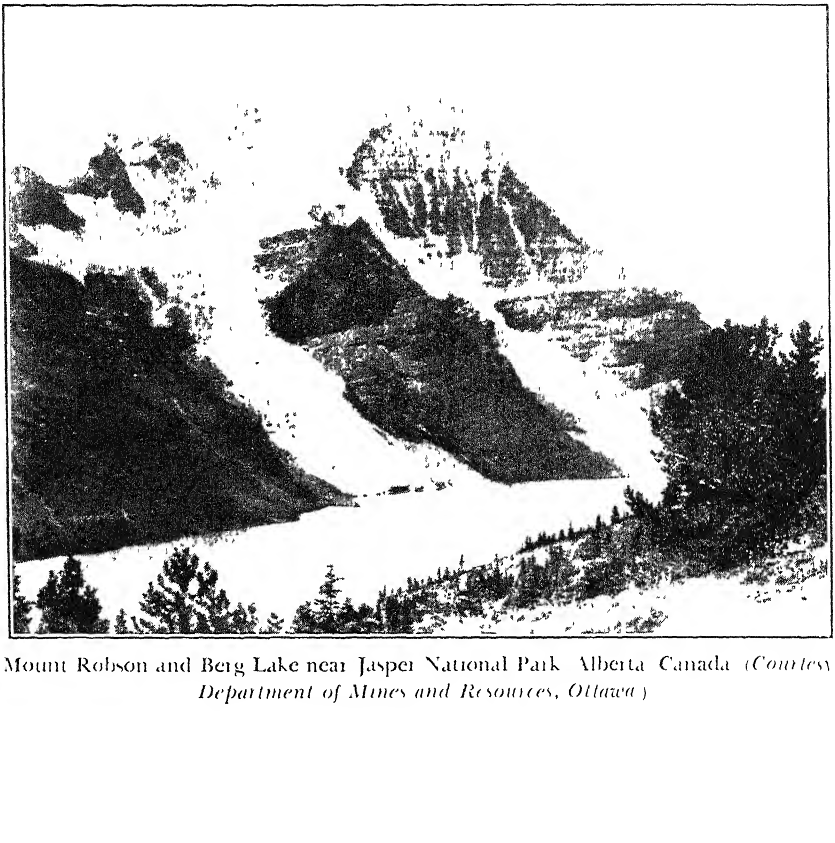

Mount Robson and Berg Lake near Jasper National Park Alberta Canada *(Courtesy Department of Mines and Resources, Ottawa.)*

The
Pacific Northwest

A REGIONAL, HUMAN, AND ECONOMIC SURVEY OF RESOURCES AND DEVELOPMENT

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FOREWORD

Distant from older and more developed areas, hemmed in by mountain and desert barriers, confronted with the economic and social problems characteristic of youth rather than maturity, Oregon, Washington, Idaho, and the mountain counties of western Montana have developed a significant unity—a unity symbolized by the name "The Pacific Northwest." In a larger sense both British Columbia and Alaska can be included in this region. In spite of marked intraregional diversity, the Pacific Northwest has a regional identity which sets it off from other areas of the United States.

The most potent element, and probably the greatest single unifying factor, in the Pacific Northwest is the Columbia River and its tributaries. This vast river system dominated the exploration and settlement of the region. Traditionally this valley has been the artery by which its people have been linked and its products distributed. East of the Cascades, economic development is dependent to a very large degree upon the life-giving waters of the Columbia system. Its lower reaches provide a navigable waterway which facilitates both intraregional and external commercial contacts. The future industrial, agricultural, and population growth of the region is inextricably bound up with the mighty Columbia.

Although marked physical diversity characterizes the various parts of the region, similarities in economic activities and problems have developed a community of interests which have been sufficiently strong to overcome the physical obstacles to regional unity. The resource pattern is regional in character. Forests, minerals, migratory fish, and agricultural and grazing land are regional resources, and regional action is essential to their effective management. Their utilization is regional in scope. With 40 per cent of the potential water power of the United States within a radius of 500 miles, vast industrial possibilities are offered, which, if developed, will further unify the region. Flood control, water supply, and transportation and marketing are problems which concern all parts of the Region and demand regional co-operation for their solution. Hence, in spite of local differences, a striking homogeneity exists, a homogeneity stimulated by economic relationships and similar cultural standards and ideals.

Compared with many other parts of the United States, the Pacific Northwest is in a pioneer stage of development. Its economy is based largely upon resource exploitation, with most of the raw materials

processed elsewhere. Approximately 90 per cent of its imports are manufactured goods. Hence, it is an important market for Eastern producers. The population is small. Although the Region comprises one-tenth of the land area of the country, it contains barely 3 per cent of the people—a total considerably lower than its resources warrant. At present only 5 per cent of the area is in productive crops, with the success of agriculture resulting from careful crop specialization. Most of the farm surplus must be marketed outside the Region. Through scientific reclamation, it may be possible to increase the cropped area by 50 per cent; part of the Region, however, will always be restricted by rugged relief, inferior soils, inadequate water supply, and remoteness from large markets.

Of paramount importance in the national economy are the Northwest forests, which cover 38 per cent of the total area. These contain nearly two-thirds of the remaining saw timber in the country and supply one-half of the nation's softwoods. The present rate of depletion raises problems of management that are of vital concern both to the nation and the region.

The Northwest, including Alaska, provides 20 per cent of the total value of United States fisheries. Sustained yield for the future, especially of salmon and halibut, calls for regional, national, and international co-operation.

A wide variety of mineral resources occurs in the Northwest, but, to date, except for coal, cement rock, and certain metals, little use has been made of them. Development of the mineral resources is affected by comparatively small demand, distance from markets, high freight rates, and limited local industrialization. Improved technology in mineral extraction and metallurgical processes, increasing demands for lighter structural metals such as aluminum and magnesium, and low-cost hydroelectric power are now stimulating production.

The youthfulness of this Pacific Realm is shown by the statistics of manufacture. In the northeastern part of the United States the value of manufactured goods per capita is $295, in comparison to $139 in the Pacific Northwest. In the processing of timber and food products, the per capita regional output exceeds that of the nation by a considerable margin, but in highly skilled manufactures the regional output is quite small. Here again new hydroelectric plants and other factors point to a considerable industrial expansion.

JOHN B. APPLETON
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Portland, Oregon

PREFACE

This book, *The Pacific Northwest,* is the first comprehensive study of the resources of the region which concerns itself with the geographic bases involved. It represents the co-operative efforts of thirty authors, all specialists in their respective fields. They are mainly drawn from universities, colleges, and technical departments of various federal services in the Northwest.

The organization of the book is based on the assumption that a knowledge of the physical characteristics and natural resources is fundamental to an accurate understanding of the economic pattern and of the problems confronting the Region. Throughout the book, regional relationships are stressed and economic, social, human, and physical factors are carefully integrated.

In addition to utilizing the published and unpublished research of many individuals and agencies, the book incorporates the results of many new investigations based upon field studies necessary to fill the gaps in regional information and to bring existing materials up to date. One of the most significant feaures of the book is the Land Form Map drawn by the cartographer, Dr. Erwin Raisz, after a field survey made during the summer of 1940.

OTIS W. FREEMAN
HOWARD H. MARTIN

November 1, 1941

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PART I

CHANGING HUMAN ADJUSTMENTS

CHAPTER 1

INDIAN LIFE OF THE PACIFIC NORTHWEST

By Erna Gunther

Since we live in a civilization where great adaptations to environment have been made, it is enlightening to study simple cultures where the relationship is more direct In the area defined here as a modern economic unit, there were two main streams of Indian cultural development, one on the Coast and one in the Plateau region To describe these patterns of life, it is necessary to throw them in relief against the picture of American Indian culture as a whole, so that their distinctive traits may be appreciated.

The American Indian belongs to the Mongoloid race and came into America from Asia about 15,000 years ago In North America he developed possibly ten distinctive cultures as well as a number of diversified physical types Archeology has shown that neither the cultures nor the physical types were static Changes have been more rapid in the last three centuries, in keeping with the general acceleration of cultural change Some of these developments took place before any European influence brought them about, but, in the area under consideration, it is probably safe to say that the greatest changes have occurred since the late eighteenth century.

Culture History

When Europeans discovered America, the Indians had developed a high type of political organization east of the Great Lakes, adobe architecture and agriculture with irrigation in the Southwest, and a seminomadic life in the Great Plains Their only domesticated animal was the dog. They used the bow and arrow intensively, and practiced the weaving of cloth and making of pottery more or less in those areas where agriculture was also carried on Into this picture the Spaniards introduced the horse and Christianity, the horse being much more widely adopted. The people of the Great Plains had both an environment and a culture into which the horse could easily be adapted They gradually became more nomadic, discarded agriculture and earth lodges to live in tipis, hunt buffalo, and spend much time decorating

their clothing and their horse trappings with paint, beads, fringe, and feathers, in art styles whose beauty is heightened through motion.

It is this changed culture of the late eighteenth century that gradually moved westward and penetrated the eastern portion of the area here under discussion. When today the Yakima, Nez Perce, and Umatilla parade in their glorious regalia they are exhibiting a very superficial and recent form of their culture. From the Flathead and Kutenai to the eastern slopes of the Cascades in Washington and Oregon, most tribes have been affected by the dramatic and colorful culture from the East. Only in southern Oregon, the Klamath, strongly influenced by California cultures, did not succumb to this invasion of spectacular ideas.

In the coastal strip of the Northwest, barred by the Cascade range from the cultural development associated with the horse, culture also quickened its pace in the late eighteenth century. The Spaniards, the Russians, the English, and later the Americans visited these shores, asking for furs which formerly had no great value to the Indians, and giving in return goods that greatly stimulated trade throughout the area. Life in this region was a competitive one based on the acquisition of wealth. When these new sources of wealth appeared, emphasis on the possession of goods was intensified with a rapid development of a system of social ranking, as exemplified by the potlatch.

Since without these outside stimuli the Pacific Northwest Indian cultures would not have presented the picture known to students today, it seems advisable to review briefly the history of this area.

Territory and Dwellings[1]

West of the Rocky Mountains the country varies from semiarid plateaus to fiord-like inlets, giving thousands of miles of shore line. The Coast Range rises directly from some of these waterways, forming an almost impenetrable barrier for the coast tribes. Their only intercourse with interior tribes was through the mountain passes, which in many instances have become the highways of today. Penetrating these mountains are also two great rivers, the Fraser and the Columbia. The

[1] Appended to this paper is a list of the principal tribes of the area with their location and the language family to which each belongs. In the brief space allotted it has not been possible to discuss the linguistic affiliations of all these tribes, but it should be apparent from this list that many languages are represented in the area. Each of these languages constitutes a totally different type of speech, not mutually intelligible and in many instances represented by many dialects. The linguistic diversity on the Pacific coast is a very striking phenomenon, frequently tribes not more than twenty-five miles apart speak languages that differ as much as English and Chinese.

coastal aspect of Thompson and Lillooet culture on the Fraser River, as compared with other tribes equally far from the coast but not on the river, shows clearly the effect of this route of travel. That the Columbia was undoubtedly a great highway is revealed by the type of archeological finds common along the river. Scattered finds indicating temporary camps and the few places where successive layers would point to continuous occupation have led to the belief that this region as well as a large part of eastern Oregon held only a shifting population. In northeastern Washington and northern Idaho the people were more stable, the Colville, Kalispel, Coeur d'Alene, and Pend d'Oreille migrated only seasonally as the search for food indicated.

Along the coast there were the following considerations in choosing a village site, protection from marauders (raiding for slaves was a widespread diversion), access to a good canoe beach, availability of fresh water, nearness of fishing grounds. Where all these conditions could be obtained a permanent winter village was built. This consisted of a number of large wooden plank houses, each sheltering two to ten families. Such quarters were used for winter villages, but, when the rains were over and fish runs began, these Indians left their villages and in family groups went to summer camps for fishing and berry picking. No village can in a short time assume a greater aspect of dilapidation and desertion than a coast Indian settlement. The first traveler to note this was Captain Vancouver, who wrote in his diary in 1792 on passing the sandspit at Dungeness, Washington, that he had seen a deserted Indian village and it looked as though some time ago an epidemic might have carried away all the inhabitants. But in reality the inhabitants were just a few miles back of the coast on the Dungeness River for a salmon run.

The summer base camp consists of a cattail mat tent, rectangular, gabled, and just large enough to accommodate one family for sleeping. Brief trips were made with just enough mats for a lean-to, or travelers depended on a windbreak of cedar boughs.

In the Plateau area there was greater diversity in dwellings. Village sites were only semipermanent, but in winter headquarters were located by preference on protected southern exposures near water and wood and in summer sites were chosen favorable for taking salmon at the rapids of the Columbia and its tributaries. The earth lodge was probably an old form of dwelling, as was the house covered with tule mats. Intrusive from the east is the tipi, the conical tent familiar in the Great Plains, coming into the Plateau from the west is the plank house, which is known only along the two rivers mentioned earlier. On

the Fraser it ascended to the Lower Lillooet and on the Columbia as far east as the Nez Perce. The earth lodges were built over a pit which might be circular or square and have a pyramidal or a flat roof. This dwelling was especially used by the southern British Columbia tribes.

The mat-covered house, rectangular with rounded ends, had a wide

FIG. 1. Indians fishing at Celilo Falls. (*Courtesy Seattle Times.*)

distribution in the eastern part of this area, although today, when these tribes move into so-called native houses in contrast to the frame houses they ordinarily live in, they use the tipi, another example of the Plains penetration that just preceded the European.

This very brief survey of dwellings should not be ended without once more mentioning the plank houses of the northern coastal area. Aside from the great adobe dwellings of the Southwest, they were the most remarkable architectural feat of the Indians north of Mexico. The placement of the roof beams 60 feet long and 2 or 3 feet in diameter without any machinery was a real engineering feat. Artistically, the great killer whales and thunder birds painted in red and black across a house, perhaps 30 to 40 feet broad and 15 to 20 feet high, are a sight to be remembered. In addition to this, the Haida incorporated

the totem pole into the house front by making the entrance through the pole It is unfortunate that the weather in this region is not so kind to these materials as in the Southwest and that the glories of this unique architecture are no longer here for us to admire.

Economic Life

The Pacific Northwest is the most extensive region in North America to support a well-developed culture without agriculture The dense forests of the coast and the semiarid plateau of the interior might be considered severe drawbacks to such a venture, but the precedent of agriculture in the semiarid Southwest shows that environmental handicaps can be overcome No other fishing, hunting, and gathering area in North America provides its inhabitants with such a bountiful supply of easily available foods, and a study, especially of the Coast economy, shows that the people took ample advantage of their opportunities The food problem in all primitive types of life is to find a way to preserve the oversupply of one season to use in the period of scarcity, and the obtaining and preparing of food stores dominate the annual economic cycle.

In spite of the differences of environment the entire Northwest was bound together by the extensive use of fish Salmon runs occur in all streams in the Pacific slope The difference in the food habits of the coast and the interior people was the proportion of fish to meat Both groups used salmon, hunted, and gathered vegetable foods On the coast the Nootka, Haida, and Makah augmented their fish with seal, whale, and porpoise The tribes along the Columbia used sturgeon; those of the interior proper used deer, antelope, and rabbits, the people with access to the Olympics hunted elk And everywhere there was no bag limit on birds.

To return to fishing, for that was the basic food supply, fishing grounds belonged to families or to individuals who were the heads of families. On the coast a wealthy and generous person when he was not using his fishing place often allowed poor people who had no fishing rights to use his station Fishing was done by men and involved the damming of streams, construction of weirs and traps behind which the fish were speared, and on the great rivers like the Fraser and Columbia spearing salmon at the falls In the gentler streams a variety of dip and drag nets were used During the heavy runs a family would camp close to the stream and the women cleaned and dried the fish for storage Fish was sun-dried or smoked according to weather and choice Alder wood was preferred for smoking.

Hunting, of course, was also done by men, the women sometimes going to a base camp to butcher and dry the meat. Frequently hunting trips were combined with berry picking. Huckleberries were the favorite dried fruit in this whole area. Indian families looked forward to a berry-picking trip with the same expectation that we anticipate a vacation jaunt. In August the Yakima can still be found in tipi camps on the slopes of Mount Adams. Although an occasional automobile reminds us that we are in the 1940's, the horse and the spring wagon are also very prominent.

Sprouts in the early spring, bulbs such as camas, among the Klamath, water-lily seeds, and in eastern Washington and Idaho the bitterroot make up the vegetable foods in common use. To this the coastal tribes added the use of shellfish, especially clams in Puget Sound and the inland passage northward.

On the coast the greatest economic activity took place from April to November, and this concentration of effort allowed a winter season of leisure, with assurance that there was sufficient food stored for a comfortable existence. A surplus supply of food was a great social asset and, before the expansion of wealth through trade goods, the surplus was used in potlatches or ceremonial feasts.

Political and Social Life

To a discussion of tribal territories on the Pacific slope we too frequently bring our own ideas of primitive political organization and distort the true pattern. The atomistic nature of political organization is brought out in this statement of Kroeber's: "From Alaska to California there does not appear to have been a group that could be designated as a political unit, other than what it is usual to call the village, that is, the settlement on one spot."[2] Then how can the areas outlined on the map with tribal names be explained?

In an analysis of Plateau culture Ray answers the question as follows:

> The answer is partly historical, partly theoretical. Early settlers, traders, missionaries, and government officials carried with them from the east the notion that all Indian groups were of necessity organized along tribal lines. Upon learning a village name from a native the whites immediately and indiscriminately applied it to all Indians of the vicinity. The term Sanpoil, for example, is a French corruption of the native name (snpui lux^{u}) of the people who lived in a single village (npui lux^{u}) located at the mouth of the Sanpoil river . . . . In other

[2] A. L. Kroeber, "Tribes of the Pacific Coast of North America," *Proceedings of the Nineteenth International Congress of Americanists*, p. 396, 1917.

cases a name of English or French derivation was applied arbitrarily, such as Colville, Columbia, and Thompson.[3]

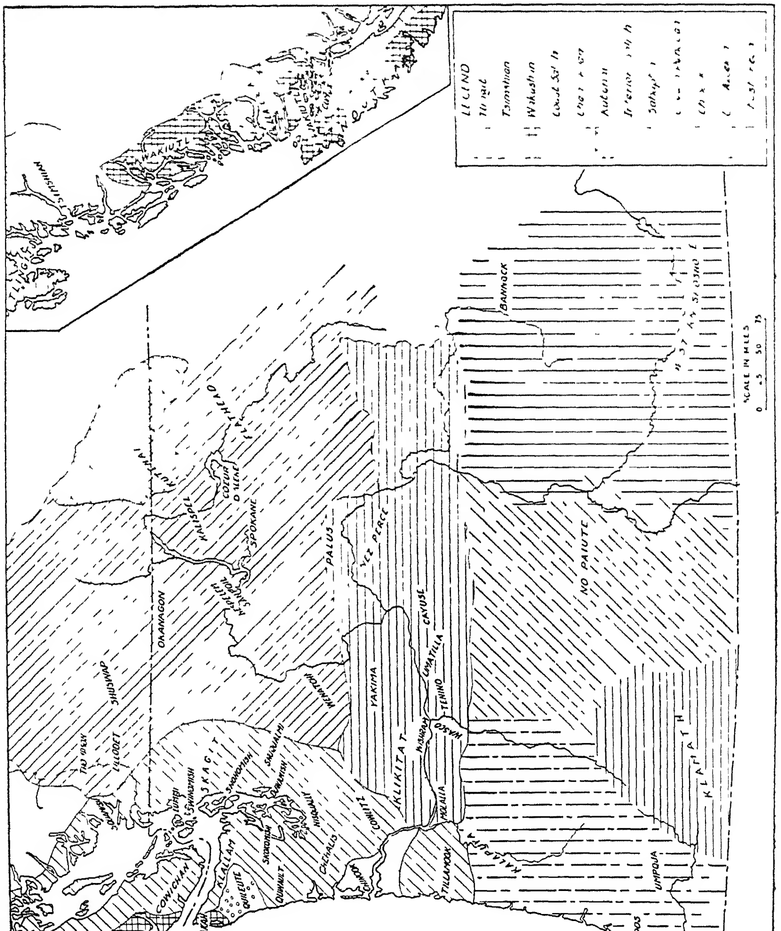
Often the Indians themselves do not recognize the tribal names in use by the whites. Furthermore, by reviewing again the type of economy prevalent throughout the area this lack of political unity can be understood. A hunting, fishing, and gathering people need a greater area for their subsistence than an agricultural group. Also they do not use most of their country the greater part of each year, but every part of it has some place in their annual subsistence cycle: one place for fishing, another for hunting deer, a long sandspit for ducks, a mountain trail to berry fields. With a large part of the so-called tribal territory used so seldom it is not surprising that the ethnographer frequently gets some slight overlapping in the statements of two adjoining tribes. This might in the old days have given rise to disputes, but usually they had more important issues at stake.

The unit of political organization therefore is the village, a statement that applies equally in the entire area. A number of villages occupying contiguous territory share many culture traits, including the language they speak. They trade together, intermarry, come to each other's ceremonies, in case of stress possibly even unite against a common enemy, but they are just as likely to turn on each other. Their relationship is in a constant state of flux. Consequently a more accurate way of recording the location of Pacific Northwest tribes would be to mark each village. New villages were often settled by people who left an old village because of quarrels.

The leader in a Coast village was usually the wealthiest man in the group who also had some qualities of leadership. His son did not necessarily become the leader after his father's death unless he also possessed the wealth and the ability, but, since he was definitely trained for his position, that succession was the usual one.

Individuals on being asked their affiliations customarily name the village in which they were reared. This generally means in many Coastal tribes that this person's father was also born in that village or, anthropologically speaking, the custom of patrilocal residence prevails. Marriages were arranged by families, and alliances were sought where political and social advantage could be gained. Among the northern Coastal tribes, the clan, a kinship group where descent was reckoned through the mother, controlled also inheritance and marriage.

[3] Verne F. Ray, "Cultural Relations in the Plateau of Northwestern America," *Publications of the Frederick Webb Hodge Anniversary Publication Fund*, Vol. III, p. 9, 1939.



TRIBES OF THE PACIFIC NORTHWEST DIVIDED INTO LANGUAGE FAMILIES

FIGURE 2

The detailed structure of society cannot be given in this brief space but a short discussion of social ideals may clarify the picture Among Coastal tribes was a strong sense of caste, strongly developed in the north and gradually diminishing southward In each group there was an upper class, common people, and slaves. The upper class was finely graded within itself so that in reality each person was in a rank of his own This grading was largely based on wealth, not actually possessed but accumulated and given away to the glory of the family name Part of this property consisted of slaves, either poor people within the tribe or captives taken in raids. The Plateau people were very unsympathetic to this class system, and also frowned on slavery, stress on wealth, and war Among the Sahaptin-speaking Plateau groups some of the Plains system of war honors gained footing in the nineteenth century, but with this exception all men were regarded free and equal Where the social ideas of the Coast ascended the Columbia and Fraser, slaves were found among the Wishram and Lillooet and Thompson

The social system of the Coast was based on the possession and distribution of surplus goods or wealth in the form of an investment. The potlatch system developed here, in fact, is one of the best-paying investment systems ever devised. The basis of it is the desire to elevate the family in the social scale of the tribe, and although one individual gives the potlatch the whole family profits by reflected glory A potlatch is a great feast to which guests are invited from many tribes and during which the host gives all the leading guests such presents as canoes, slaves, food, and in more recent years commercial blankets Each guest in receiving these gifts obligates himself to give the donor a gift that is larger by 50 to 100 per cent The relative status of host and guest is reflected in the size of the gift, the host giving only to such guests as are certain to fulfill their obligations, in other words, a guest's credit must be good If contact with white peoples had not disrupted this system, it would have been interesting to see how long it could have withstood the lack of balance created through the accumulation of wealth in the hands of a few families

This system prevailed especially in the northern part of the Coastal area, and to a lesser degree south to the mouth of the Columbia In the interior, it was not observed and in consequence the social system was less complicated or definitive.

Ceremonial and Religious Life

On the Coast, as in the interior, the quest for an individual guardian spirit was the basis of religious life. But in that area on the Coast, where

the secret society and the attendant ceremonials of the potlatch dominated, the guardian-spirit concept was less prominent. Throughout the region, except among the Plains-influenced Kutenai, Flathead, Bannock, and western Shoshone, ceremonial life was at its height in the winter with the winter festival of the Coast and the spirit dances of the Plateau as the leading features. These ceremonials involve dancing, gambling, and much intertribal visiting.

The secret society previously mentioned was a dominant factor in the ceremonial life on the Coast, centering among the Kwakiutl. This society was often called the false power because it did not derive its supernatural strength from a legitimate spirit quest. In its initiation ritual the novice was supposedly killed and restored to life, and in order to maintain this illusion the uninitiated were kept at a proper distance, and the rites were carried on largely under the cover of darkness. Membership was again tied up with the establishment of social prestige; the younger a child was inducted, the greater the credit to its family.

In conclusion the following major points should be reiterated:

1. The area defined here includes two main streams of Indian cultures, the Coast and the Plateau.
2. Although the environment differs considerably, both cultures are a hunting and fishing type with fishing predominating except in the easternmost part, beyond the watershed of the Columbia.
3. The social life of the Coast is dominated by social class and wealth, the Plateau is essentially democratic with a slight infiltration of the war complex of the Plains.
4. The basic religious concept is the guardian-spirit quest, overlaid on the Coast by the secret society.
5. Even before white civilization disrupted Indian life, these cultures were not static but underwent appreciable changes through contacts with one another.

TABLE 1

GAZETTEER OF PRINCIPAL TRIBES OF THE PACIFIC NORTHWEST

Tribe	*Location*	*Language*
Bannock	Southern Idaho	Shoshone
Bella Coola	Dean Channel, British Columbia	Coast Salish
Cayuse	Northeastern Oregon	Sahaptin
Chehalis	Grays Harbor	Coast Salish
Chinook	Pacific coast of Washington, mouth of the Columbia	Chinook
Coeur d'Alene	Border of Idaho and Washington	Interior Salish
Comox	Northeastern Vancouver Island	Coast Salish
Coos	Southwestern Oregon	Oregon Penutian
Cowichan	Southern Vancouver Island	Coast Salish

TABLE 1 (*Continued*)

Tribe	*Location*	*Language*
Duwamish	Puget Sound	Coast Salish
Flathead	Western Montana	Interior Salish
Haida	Queen Charlotte Island	Haida
Kalapuya	Northwest Oregon	Oregon Penutian
Kalispel	Northeastern Washington	Interior Salish
Klallam	North shore, Olympic Peninsula	Coast Salish
Klamath	Southeastern Oregon	Sahaptin
Klickitat	South-central Washington	Sahaptin
Kutenai	Western Montana	Kutenai
Kwakiutl	North Vancouver Island	Wakashan
Lillooet	Fraser River	Interior Salish
Lower Chinook	Pacific coast of Washington, mouth of the Columbia	Chinook
Lower Cowlitz	Lower Valley, Cowlitz River	Lower Salish Upper Sahaptin
Lummi	Northwestern Washington	Coast Salish
Makah	Northwestern Washington	Wakashan
Molala	North-central Oregon	Sahaptin
Nespelem	Big Bend of the Columbia River	Interior Salish
Nez Perce	Border of Idaho, Oregon, and Washington	Sahaptin
Nisqually	Southern Puget Sound	Coast Salish
Nootka	West coast of Vancouver Island	Coast Salish
Northern Paiute	Southeastern Oregon	Uto-Aztekan
Okanagon	North-central Washington and south-central British Columbia	Interior Salish
Palus	Eastern Oregon	Sahaptin
Pend d'Oreille	Border of Idaho and Washington	Interior Salish
Puyallup	Southern Puget Sound	Coast Salish
Quileute	Northwestern Washington	Chemakuan
Quinault	Pacific Coast, Washington	Coast Salish
Sanpoil	Big Bend of Columbia River, Washington	Interior Salish
Shuswap	Fraser River	Interior Salish
Skagit	Skagit River, Washington	Coast Salish
Snohomish	Puget Sound	Coast Salish
Snuqualmi	Puget Sound	Coast Salish
Spokan	Eastern Washington	Interior Salish
Squamish	Southwestern British Columbia	Coast Salish
Swinomish	Puget Sound	Coast Salish
Tenino	North-central Oregon	Sahaptin
Tillamook	Northwestern Oregon	Coast Salish
Tlingit	Southeastern Alaska	Tlingit
Tsimshian	Northwestern British Columbia	Tsimshian
Umatilla	Northeastern Oregon	Sahaptin
Umpqwa	Lower, southwest coast of Oregon Upper, Umpqwa River	Oregon Penutian Athapascan
Upper Cowlitz	Upper Valley Cowlitz River	Sahaptin
Wasco	North-central Oregon	Chinook
Wenatchi	North-central Washington	Interior Salish
Western Shoshone	Southern Idaho	Shoshone
Wishram	South-central Washington	Chinook
Yakima	Central Washington	Sahaptin

CHAPTER 2

EXPLORATIONS, POLITICAL ADJUSTMENTS, AND SETTLEMENT

By C. S. Kingston

The early history of the Pacific Northwest is closely related to the histories of other countries and other peoples. To understand its backgrounds many references must be made to the explorations, settlements, and territorial claims made along the western coast of North America by the Spanish and the Russians, and to the still more important work of the British and Americans, who, in addition to coastal exploration, developed an economy adapted to the natural resources of the region, established permanent settlements, linked the northwestern coast to the eastern seaboard by exploring the continental interior, and determined its national relations as well as its political and social institutions.

The First Explorers

Among the habitable areas of North America the Pacific Northwest was the last to be explored. It is on the west side of the triangular continental land mass far away from the Atlantic shore where the first European settlements were made. Between these settlements and the Pacific Northwest was a vast region, three thousand miles wide, with immense mountain ranges and broad forests, the exploration of which required the greater part of two centuries. A period of 186 years stands between the Jamestown settlement in 1607 and the year 1793, when Alexander Mackenzie reached the Pacific—the first European to cross the continent in the zone of its greatest width. However, there are other and easier approaches. Early in the sixteenth century the Spaniards were in the Pacific in the most advantageous position to carry the work of exploration and occupation up the coast and into the region of the Northwest. Why they did not explore and occupy this area may be explained by a complex of reasons—its remoteness and apparent lack of those materials that appealed to Spanish exploitation motives, financial difficulties, governmental restriction on Pacific trade, colonial satiation, and matters of national policy growing out of European con-

ditions. Nevertheless, in two periods separated by nearly two hundred years Spanish enterprise made remarkable progress

The first period was in the sixteenth century After Balboa discovered the Pacific in 1513 and Cortes conquered the Aztecs, the work of exploring both the northern interior and the west coast went on apace. Between 1533 and 1543 Jiminez discovered the peninsula of southern California, Ulloa explored the Gulf of California and the greater part of the west coast of the peninsula, Cabrillo and Ferrelo explored the coast as far as southern Oregon, and the Coronado expedition reached the great canyons of the Colorado and traversed the vast plains east of the mountains. Then, with the Spanish occupation of the Philippine Islands, which occurred about twenty years later, there came a new incentive for west coast exploration In 1565 Urdaneta proved that the steady winds north of the fortieth parallel furnished the best passage for ships returning from Manila, and this course was followed thereafter on eastward voyages In addition, the California coast was explored and the port of Monterey, discovered by Viscaino in 1602-1603, was recommended as a stopping place for refitting and supplying the ships

But no port of California was established, and the colonial administration seemed to have virtually forgotten the upper California region for nearly two hundred years Then Spanish interest was reawakened by accounts of the settlements of Russian hunters and traders along the islands of the Bering Sea and on the American mainland in the wake of the voyages of Bering and Tchirikov. Apprehensions were entertained that the Russians intended to extend their sphere of influence southward along the western coast of the continent and thus into an area claimed by Spain. Upper California had been too long neglected and its occupation was begun by the establishment of missions and presidios. Ships were dispatched to the north for the double purpose of exploring the coast and discovering evidences of Russian advances. In 1774 Juan Pérez discovered Nootka Sound and reached latitude 55 degrees, but he found no trace of Russian settlements.

In the following year Heceta and Quadra continued the work of Pérez, and in that year Europeans first set foot on the soil of the Northwest. On July 14, 1775, a party from the Spanish ship, *Santiago,* under the command of Naval Lieutenant Don Bruno Heceta, landed at Point Grenville, 30 miles north of Grays Harbor in 47 degrees and 20 minutes north latitude This was the year of the battles of Lexington and Bunker Hill English settlements had been in existence along the Atlantic coast for 168 years, and during that time had grown into 13

colonies containing two and one-half million people and extending all the way from Maine to Georgia.

During the next twenty-five years the whole coast was carefully explored and mapped, many vessels came to trade European goods for furs, and, in one sharp clash of international interests, a difficulty arose which nearly dragged Great Britain and Spain into war. This was the Nootka controversy, and after the difficulty was settled the Spanish withdrew from the Northwest coast.

A settlement was made by the Spaniards at Nootka in 1789-1790 and a temporary settlement in 1792 at Neah Bay on the south side of Juan de Fuca Strait. The excellent work of the Spaniards in exploring the Vancouver Island region at this time should be recognized.

The Maritime Fur Trade

The English also came at this time. The first of their expeditions was that of Captain Cook, whose third official voyage to the Pacific brought him to the Northwest coast in 1778. He refitted his ships in Nootka Sound, and from that point skirted the outer coast to the Arctic. After Cook's death and more explorations in the north, the expedition sailed to Canton, China, where sea otter skins, purchased at trifling cost in Nootka Sound, were sold for high prices to eager Chinese buyers. Beginning in 1785 these opportunities caused a number of English sea captains to engage in the Northwest fur trade.

A few French traders came to the coast during this period and one official French expedition commanded by La Pérouse. American traders also appeared, of whom the best known are Captains Kendrick and Gray. Gray is to be remembered as the discoverer of the Columbia River, which he entered May 11, 1792.

Of major importance in English exploration was the work of George Vancouver, who, as commander of a British governmental expedition, made a careful survey and maps of the Northwest coast in 1792-1794.

As time went by, the British trade declined partly at least because of the necessity of securing licenses from the East India and the South Sea Companies. As these monopoly restrictions operated against only British subjects, the Americans were unhampered and did most of the fur-trading business along the Northwest coast. Some ships probably are not recorded, but 82 American ships are known to have engaged in the trade between 1790 and 1814, whereas during the same period only 26 British ships made their appearance. The fur most sought after was the sea otter's. The hunting of the otter was overdone, however, and finally the animals became very scarce. During the period of maximum

production the Chinese market, where the sea otter was in greatest demand, became glutted, and prices fell disastrously Aside from financial risks the business was hazardous in other ways—stormy seas—uncharted coasts—the danger of Indian capture Many voyages yielded little, but in other instances remarkable profits were made. Captain Sturgis, who was himself engaged in the Northwest maritime trade, cites one case when an investment of $50,000 resulted in a gross return of $285,000.

The furs were purchased from the natives with European goods selected to meet the Indian taste and needs The ships then would often sail to the Hawaiian Islands to pick up such additional products as sandalwood, tortoise shell, and shark fins to sell to Chinese merchants. In Canton the cargo would be exchanged for silks, teas, porcelain goods, etc , for the American market.

Across the Continent to the Northwest

By the close of the seventeenth century the French had explored the region around the Great Lakes, and early in the following century projects for penetrating the continent to the Pacific were considered by Governor Vaudreuil and Intendant Begon In 1731 Pierre Gaultier de La Vérendrye, having obtained government grants to the fur trade beyond Lake Superior, explored the waterways leading from Lake Superior to Lake Winnipeg Several posts for the Indian trade were built, the Mandan Indians on the Missouri were visited, and a considerable area in the very central part of the North American continent was explored Two of the sons of La Vérendrye visited (1742-1743) regions west of the Missouri and saw ranges of mountains to the westward that may have been part of the Rocky Mountain system After his death other traders established relations with the Indians farther up the Saskatchewan River in the neighborhood of the present city of Calgary.

After the French and Indian War, Scotch, English, and American traders made their way by the Great Lakes to Lake Winnipeg and then by the intricate waterways beyond Lake Winnipeg on toward the West and North Among these were Joseph Frobisher, Peter Pond, and the elder Alexander Henry A few years later these intrepid traders merged their interests in an organization known as the North West Company of Canada and continued energetically exploring the unknown western regions and developing the fur trade

Alexander Mackenzie descended the Mackenzie River and reached the Arctic in 1789 Four years later he crossed the Rocky Mountains,

the region of the upper Fraser River, and the coast range, reaching Dean Channel, July 22, 1793, by way of the Bella Coola River. To Mackenzie belongs the honor of being the first European to cross the North American continent north of Mexico. Fifteen years later Simon Fraser explored the lower stretches of the Fraser River, where rapids and falls within precipitous gorges make ordinary river navigation

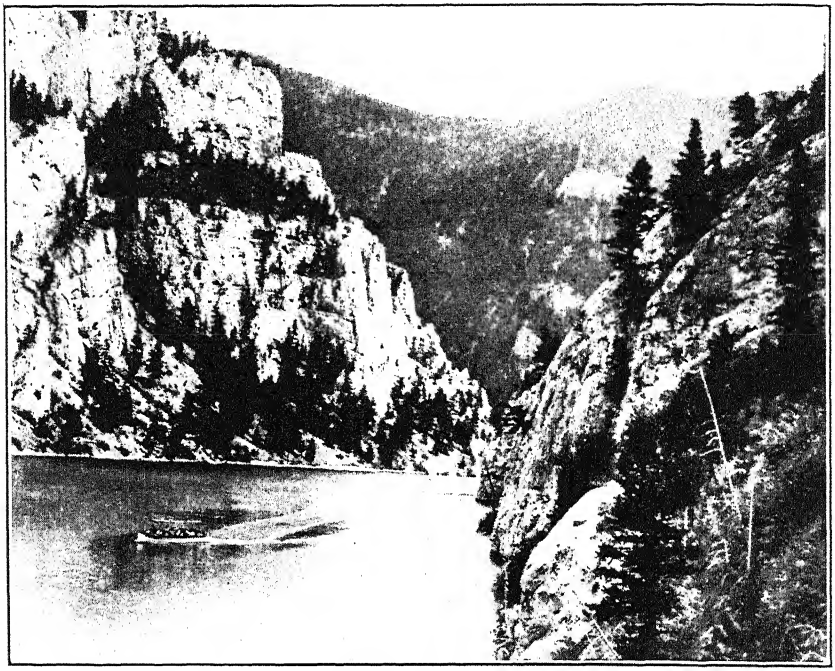


FIG. 3. Gates of the Mountains near Helena, where the Missouri River flows through the Rockies. The Lewis and Clark Expedition discovered and named this place in 1805. (*Courtesy Northern Pacific Railway.*)

impossible. David Thompson, after serving an apprenticeship in the Hudson's Bay Company, joined the North West Company and crossed the Rocky Mountains to the headwaters of the Columbia River, where in 1807 he built a trading post at Lake Windermere. During the next few years Thompson explored carefully the complex of mountain ranges and river valleys which form the northwest portion of the Columbia drainage basin—the Columbia River from its source to its confluence with the Snake River, together with the Kootenai and Clark Fork rivers. Thompson was an excellent mathematician and cartographer, and his maps and journals are of great importance both to the

history and to the geography of the Northwest. Among the trading posts which were built under his direction were Kootenai, Kullyspell, Saleesh, and Spokane, located on the Spokane River ten miles northwest of the present city His name is preserved in Thompson Falls in Montana and Thompson River in British Columbia.

The Lewis and Clark Expedition is the most important single achievement in the annals of the exploration of the American West The honor of originating this undertaking belongs to Thomas Jefferson. The party ascended the Missouri River in 1804 as far as the Mandan villages near the Montana line. Here they spent the first winter, continuing up the Missouri in the spring of 1805. Ascending the river almost to its source, Lewis and Clark crossed the continental divide and, on the advice of the Shoshone Indians, made their way down the valley of the Bitterroot to a point not far from the present city of Missoula From this point they followed an Indian trail across the Bitterroot range to the Clearwater River, where they constructed canoes in which they descended the Clearwater, Snake, and Columbia rivers to the Pacific They remained at Fort Clatsop, as they called their palisaded cabins, during the winter of 1805-1806 In 1806 the party returned safely to St. Louis after an absence of two and a half years On the return two side trips were made, Lewis with a few men explored Marias River, and Clark with a larger party the Yellowstone The Lewis and Clark Expedition demonstrated the practicability of an overland route to the Pacific and the wealth of furs available in the Northwest.

The Astorians

Five years after Lewis and Clark left Fort Clatsop the American ship *Tonquin* entered the Columbia River bringing the first Astorian party A building site was selected on the south side of the river, the supplies were landed, and all those who were to remain began the erection of the necessary structures and the surrounding palisade The *Tonquin* departed on a voyage up the coast to trade with the Indians.

John Jacob Astor had come to the United States nearly thirty years before Astoria was begun. He had become wealthy in the fur business, and the American Fur Company which he had founded was one of the great enterprises of that day. He decided to start another fur company to trade on the northwestern coast and in the Columbia River interior His plan was to maintain a central establishment near the mouth of the Columbia with smaller posts in the upper country, these were to be supplied with goods carried by sea from New York The ship that brought the goods was also to collect furs along the coast and to trade

with the Russians in Alaska. Then with choice furs for the Chinese market it would sail to Canton, and from that port bring back Chinese goods to be sold in the United States.

To carry out this plan Astor enlisted several partners—young men who had already gained fur trading experience and were willing to join Astor's enterprise for a share in the profits. Two parties were organized, one to go with the *Tonquin* by sea while the other crossed the continent by the Missouri River route.

The second party, known as the Overland Astorians, was informed when it reached the Arikara villages in present-day South Dakota that the hostility of the Blackfeet would make it impossible to ascend the Missouri as planned. Willis Price Hunt and Donald Mackenzie then led the party westward across plains and mountains until they reached the Snake River; here they turned loose the horses which they had obtained from the Arikara Indians, constructed boats, and started down the Snake River. But soon river navigation became so difficult that they abandoned their boats and started for the mouth of the Columbia River by land. They had no horses, game was scarce, and they suffered greatly, but most of the party succeeded in reaching Astoria in January and February of 1812.

The Astorians started one trading post at the mouth of the Okanogan River and another at the junction of the Spokane and the Little Spokane close to the North West post, Spokane House. For a time the Astorians were very active in pushing their trade. Donald Mackenzie went to the Nez Perce country, Ross Cox traded among the Flathead, and David Stuart did an excellent business with the Indians on the Thompson River, north of the forty-ninth parallel.

Despite difficulties and losses of life at the beginning of the enterprise, it is probable that the Astor company would have succeeded if the War of 1812 had not broken out. The news of the war was brought to Astoria by their rivals of the North West Company. The Astorians were in a difficult position, and they decided to sell the property to the North West Company. This organization took over Astoria, changing the name to Fort George; they also acquired the interior trading posts of the Pacific Fur Company.

The sale was made in 1813, and during the next decade the North West Company of Canada represented British interests in the Pacific Northwest. There were no Americans left in the country, although American vessels came to trade with the natives along the coast. The failure of Astor's enterprise was a blow to American interests. Had it succeeded the history of the Northwest might have been greatly changed.

The Fur Economy Period

The first resource of the Northwest to be exploited was fur, ships came and explored the coast in search of fur, the fur trade led men in the interior to explore the river systems and mountain ranges. The great British companies—the North West Company of Canada and the Hudson's Bay Company of England—furnish a historic background for the exploration and occupation of the northern areas, whereas the activities of the American companies—Missouri Fur Company, American Fur Company, Rocky Mountain Fur Company—and of many partnerships and individual traders explain many of the historic events on the American side of the border Missionaries, travelers, and some settlers crossed the great plains under the protection of the fur traders. When the business of trapping was over some men who had been in the service of the companies settled on the fertile lands of the Willamette Valley In the list of American fur traders are many distinguished names—Manuel Lisa, Andrew Henry, William Henry Ashley, J. S. Smith, the Sublettes, Ramsay Crooks, the Chouteaus, Kenneth Mackenzie, Jim Bridger, Thomas Fitzpatrick, Captain Bonneville, Nathaniel Wyeth—names that will always be remembered as a part of the old American west.

To settle the bitter rivalry once for all between the Hudson's Bay and the North West companies, Parliament provided in 1821 for the merger of the two The new organization bore the old name, The Hudson's Bay Company, but the North West partners were allotted the same amount of stock as their opponents The consolidation was followed by a general reorganization of the business throughout the trapping and trading areas of British North America Thereafter the name, North West Company of Canada, disappeared, and the fur business of western British America was wholly managed by the Hudson's Bay Company

The first results in the Northwest were a partial abandonment of Fort George (Astoria) and the establishment of a new and larger post known as Fort Vancouver where the present city of Vancouver, Washington, stands The open country and deep water navigation were determining factors in the selection of the site For many years Fort Vancouver was the center of European enterprise in the Northwest. The fort itself was a palisaded rectangle enclosing some five acres; the pickets were fifteen feet high, within were two courts which contained more than twenty buildings Here officers and clerks lived, here were storehouses for furs, trading goods, grain, and workshops where carpentry, blacksmithing, barrel making, etc., were carried on.

Outside the fort was a village of some fifty small houses where the employees of the company lived with their Indian wives. A large farm, extending over several thousand acres, was carefully tilled and herds of cattle and other domestic animals were kept. There was a grist mill, a saw mill, and a large dairy. Wheat was raised to supply flour to the inland posts, and pork and beef were packed for similar purposes. Flour, meat, and other products were traded to the Russians in Alaska. From Vancouver as a supply point some twenty secondary posts both up the coast and in the interior of the Columbia Basin were furnished the goods required in the Indian trade. The Columbia River was the usual artery of communication with the East. From Vancouver, boats ascended the river to Boat Encampment and from that point a trail led the travelers along Portage River and over Athabaska Pass in the Rocky Mountains.

Among the secondary posts established were Fort Nisqually, located near the southern end of Puget Sound and adjacent to extensive prairies. In the Columbia Valley trading posts were built at points from which trails diverged into the fur-producing country. Among the posts on the Columbia were Fort Walla Walla, near the present site of Wallula, Fort Colville near Kettle Falls, and Fort Okanogan at the confluence of the Okanogan and Columbia rivers. From Fort Okanogan goods were transported as far north as Kamloops in British Columbia, since the Fraser River was impracticable for navigation. Considerable farming was carried on in the Colville Valley, and livestock was also kept there and at Fort Walla Walla. In Idaho Fort Boise, west of the present city of Boise, and Fort Hall, near Pocatello, originally founded by Nathaniel Wyeth, were convenient locations for Indian trade. Spokane House was occupied only until 1826. Only a few of the old fur-trading posts had locations favorable for modern railroad and highway transportation and became cities. For the most part the sites were abandoned with the close of the fur epoch.

For more than twenty years Dr. John McLoughlin was the head of the Hudson's Bay Company in Oregon, and all persons who came in contact with him were impressed by his noble appearance, fine character, generosity, and kindliness.

The Missionaries

There are certain events that stand out in strong relief, marking the history of the Pacific Northwest in the different decades of the nineteenth century. Lewis and Clark came in the first decade, the Astorians and Northwesters in the second; in the third the Hudson's Bay consolidation took over the entire fur business and only an occasional

American like J S Smith came into the Pacific Northwest And in the fourth decade, 1831-1840, the missionaries appeared The Lees, Whitman and Spalding, Eells and Walker, and the Catholic missionaries, Demers, Blanchet, and De Smet. came to Oregon, as the whole Northwest was then called

Jason Lee, who was sent to the Northwest by the Methodist Church, started his work in the Willamette Valley in 1834. Three years later a reinforcement of twelve men and women came by ship, and in 1840 another ship, the *Lausanne*, brought to Oregon what was called the "Great Reinforcement," consisting of over fifty people. Many of these lived out their lives in the Willamette Valley and strongly influenced its educational and religious life.

The American Board of Commissioners for Foreign Missions, a co-operative missionary organization of the Presbyterian, Congregational, and Dutch Reformed churches, sent Dr Marcus Whitman and the Reverend H H Spalding to Oregon in 1836 Their wives, who accompanied them, were the first women to cross the American continent Dr. Whitman located at Waiilatpu and Spalding at Lapwai. Waiilatpu is six miles west of Walla Walla and Lapwai is on the Clearwater River in Idaho After Whitman and Spalding, other missionaries of the American Board came to the Northwest, the most notable being Cushing Eells and Elkanah Walker, who located at Tshimakain north of the Spokane River. The work in the interior continued until 1847, when the massacre at Waiilatpu put an end to the efforts of the American Board for many years

Fathers Blanchet and Demers came in 1838 and Father De Smet began his work among the Flatheads in 1840 In the Willamette, where many former employees of the Hudson's Bay Company were living, St. Joseph's School for boys and St. Mary's School for girls were opened. To assist the early missionaries, priests and sisters of the Notre Dame de Namur order came to the Oregon country The missionary work of the Catholics among the Indians was carried on effectively with a thorough organization, a distinctive garb, celibacy, and the absence of personal secular interests. When the large American immigration began in 1843, Catholic influence in the Willamette Valley diminished because the majority of the immigrants were Protestants.

Coming of the Pioneers—The Provisional Government

If the decade of the thirties was the period of missionary endeavor, that of the forties marked the arrival of the American pioneers They were not sent out by fur companies or church organizations They

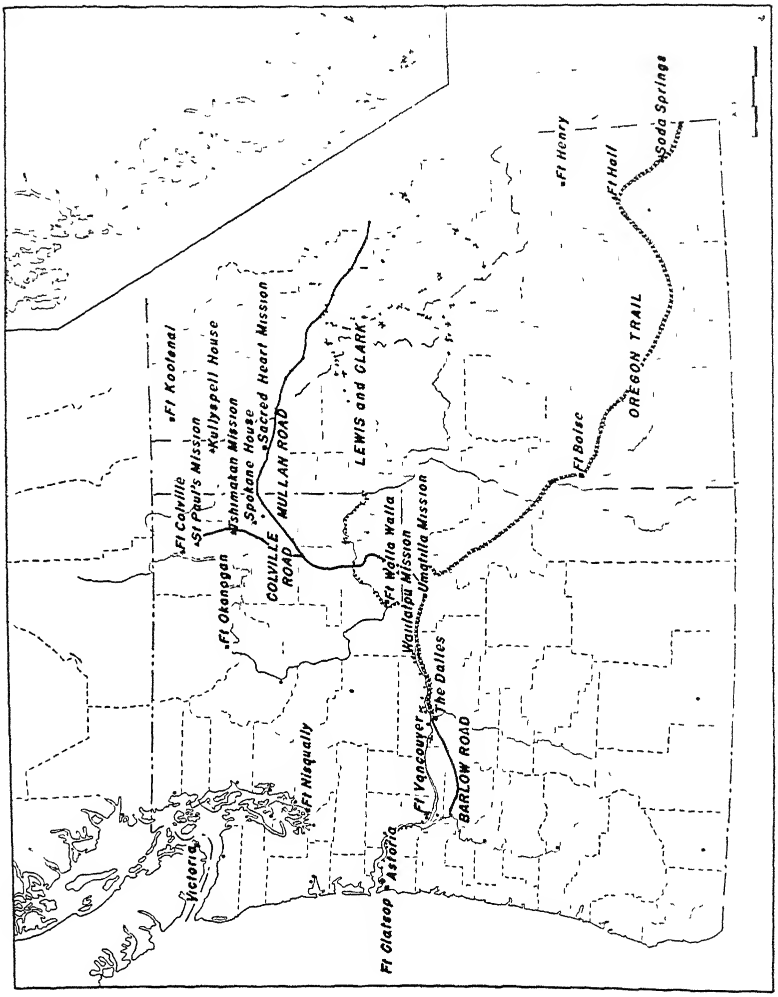


FIG. 4 Historic routes and settlements in the Pacific Northwest

were permanent settlers who came to Oregon with their families because they believed it was a good country in which to live W H. Gray, then a resident of the Willamette Valley, states that there were 137 American men, women, and children in Oregon in 1840 Some of them had come because of missionary undertakings, then there were "mountain men" like Joseph Meek and Robert Newell who, after years of trapping in the mountains, had come down to the valley to live, others had come with Nathaniel Wyeth or Ewing Young in 1832-1834, or with the Peoria party of 1839 The British element in the valley was composed of Canadians who had been employed by the Hudson's Bay Company for years and who had now settled here with their Indian wives and children. Such was the situation in Oregon before the large pioneer movement began

The Hudson's Bay Company looked after the interests of the Canadians, and the Americans sent several petitions to Washington asking for the protection of their own country. To meet the temporary needs of the residents in the Willamette a provisional government was organized in the spring of 1843, which continued with some modifications until 1849 It was organized on a voluntary basis but secured the general support of the people. The Hudson's Bay Company gave its adherence to the provisional government in 1845 The oath to support the provisional government was worded so that the deponent was not required to surrender his national allegiance The provisional government of Oregon is an example of the ability of people of American and British traditions to govern themselves peaceably during a period of transition

The interest of the outside world in the Northwest at this time is shown by a number of notable visitors and expeditions Wilkes's expedition was sent out by the United States to Oregon in 1841, Sir Edward Belcher was on the lower Columbia in 1839, John C Fremont in 1843, and Sir George Simpson and Eugen Duflot de Mofras in 1841.

Before the caravans of settlers started for the Pacific coast there was a nucleus of Americans who had already made their homes in the Willamette There was also a marked interest in the Northwest among Americans who lived in the eastern states This was displayed in the newspapers and in discussions of the Oregon question in Congress Emigration societies were organized to encourage and assist people who were willing to go to the Oregon country. An Oregon convention was held in Cincinnati in July, 1843, and was attended by delegates from several western states The widespread sentiment in favor of the Oregon country is shown in the platform of the Democratic Party in 1844.

Among the reasons that influenced people in the Mississippi valley to think of emigrating to Oregon were the years of depression that followed the business crisis of 1837; financial difficulties resulting from internal improvements undertaken by western states, overproduction of agricultural products in the Mississippi Valley and inadequate transportation therefor; and the hope of securing land without paying the usual governmental price. Then too the pioneers commonly believed that Oregon was a more healthful country than the middle west and that a large market for Oregon products existed in the Orient To all these reasons were added the restlessness and mobility of a frontier population with a tradition of moving ever westward from the settled to the new lands of America The emigration to Oregon from 1840 to 1850 was a significant incident in the occupation of the continent by the American people The distance to be covered was greater than in any previous movement of the American frontiersmen, but the pioneers believed from the accounts of those who had gone over the route that the journey was practicable.

The emigration parties would gather in the spring at Independence and Westport in western Missouri where they organized by choosing leaders to direct the march. Starting about the first of May and averaging twelve to fifteen miles a day with teams of oxen, horses, and mules, they would arrive in western Oregon in the fall if there were no accidents or unusual delays. The distance was approximately 2,000 miles, the route became known as the Oregon Trail It led from Independence, Missouri, to the Platte River and then to Fort Laramie, it crossed the Rocky Mountains at South Pass and went on to Fort Hall in the neighborhood of the present city of Pocatello. Next it followed the Snake River and across the Blue Mountains to the Columbia River at the mouth of the Umatilla and down the river to the Willamette Valley—the last stage sometimes by raft or boat. The crossing of the Cascades was made easier by the building of the Barlow toll road south of Mount Hood in 1846.

Nearly 15,000 people are estimated to have crossed the plains and mountains to Oregon during the period of 1840-1850 Some returned and some went on to California, but the census of 1850 shows that there were 13,294 white people in the Oregon country. Most of this population lived in the Willamette Valley as only 1,201 had settled north of the Columbia River

The Oregon settlers led a simple Arcadian life The typical pioneer home was a log cabin with puncheon floors. The settlers produced their own food—wheat, garden vegetables, milk, poultry, and meat prod-

ucts. The streams provided fish and the forests game There was little money, and for a time wheat was a medium of exchange Farm implements were home-made, grain was cut with a cradle and threshed with flails or trampling horses, the grain was winnowed in the breeze Buckskin was in demand for clothing, as was elk skin for shoes, common textiles and manufactured boots and shoes could be bought at Vancouver as well as salt, sugar, coffee, tea, tobacco, powder, lead, and some implements and tools Lack of means exacted extreme economy of the people Gradually as time went by frame houses were built, towns grew up, business activity and trade increased, and more comforts appeared in the settlers' homes.

The Settlement of the Boundary Question

In 1819 the United States bought Florida from Spain and Spain ceded to the United States all her claims on the Pacific north of the forty-second parallel of latitude In this way the 1819 treaty set a southern boundary to that loosely defined region known as the Oregon country Its eastern boundary was the Rocky Mountain watershed Then a few years after the 1819 treaty a series of diplomatic events provided a northern boundary In 1821 an imperial Russian ukase declared that Russian rights on the coast extended south to the fifty-first parallel This extension of Russian demands was opposed by both the American and British governments, and this opposition was one of the causes of the formation of the Monroe Doctrine However, Russia did not insist on the fifty-first parallel, and in 1824 the United States made a treaty with the Czar's government in which both countries agreed that the boundary line should be fifty-four degrees and forty minutes north latitude The following year Great Britain accepted the same parallel as the northern boundary of the Oregon country, thus leaving only two claimants—the United States and Great Britain.

In 1818, the United States and Great Britain had agreed on the forty-ninth parallel as the boundary between British North America and the United States from the Lake of the Woods to the Rocky Mountains, but had not been able to agree on a boundary from the Rocky Mountains to the Pacific The Americans proposed the forty-ninth parallel, but the British wanted the Columbia River Not being able to settle the dispute at the time, they agreed that during the next ten years the country might be jointly occupied by the citizens of both nations. In 1827 it was decided that the joint occupation of the Oregon country would be indefinitely extended with the proviso that either country might terminate the arrangement on twelve months'

notice In the years that followed the Oregon question was frequently before Congress and the executive department During this period the United States government showed no disposition to accept a settlement which would yield its early claims to the forty-ninth parallel as the boundary while Great Britain continued to insist on the Columbia River When American settlers began to go to Oregon in large numbers in 1843 and the years following, the British government became less insistent upon its earlier demands—an attitude which may also have been influenced by the "54-40 or fight" slogan in the Democratic campaign of 1844 In 1846 the British government accepted the forty-ninth parallel, with the United States conceding British ownership of all Vancouver Island Although this was less than the administration had demanded in its campaign two years before, it was thought best to accept the offer and thus settle the boundary controversy Looked at dispassionately after a lapse of nearly a century, it seems to have been a fair and reasonable settlement The American claims rested upon the Spanish explorations, the discovery of the Columbia River, the exploration of the southern interior by Lewis and Clark, the establishment of Astoria, and the contiguity of the Oregon country to our territory east of the Rocky Mountains Great Britain's claims paralleled those of the United States and had particular force when applied to the northern part of the Oregon country the discovery and explorations of Drake, Cook, and Vancouver along the coast, and of Mackenzie, Thompson, Fraser, and others in the interior, its occupation by the fur traders and the contiguity of the northern part of the region to British territory east of the continental divide.

Indian Wars

The period of pioneer settlement which began about 1843 was followed by a series of Indian Wars The causes of these racial struggles were essentially the same as in earlier conflicts with the natives east of the Mississippi The Waiilatpu Massacre of November, 1847, in which fourteen people, including Dr and Mrs. Whitman, lost their lives, brought on the Cayuse War As there were no regular soldiers of the United States in the territory, the provisional government raised a force of volunteers and invaded the Cayuse country. It ended with the surrender of five members of the tribe accused of participating in the Whitman massacre, their trial, and their execution at Oregon City.

The Indian policy of the American government was to place the Indians on reservations Both Joel Palmer, superintendent of Indian Affairs for Oregon Territory, and Governor Stevens of Washington

Territory pushed this program as rapidly as possible. The United States was to guarantee the fishing and hunting privileges of the Indians, establish schools, build mills, shops, hospitals, and pay instructors to teach the tribesmen to operate them, and grant a salary to the head chief. Liquor was to be excluded from the reservation, and the tribes were to remain at peace with their neighbors

A number of treaties were made with the Indians living west of the Cascades, and in the spring of 1855 Palmer and Stevens opened negotiations at Walla Walla with the Umatilla, Yakima, Cayuse, Walla Walla, and Nez Perce tribes The chiefs finally consented to accept the reservation plan but, with the exception of the Nez Perce, their consent was given with manifest reluctance Later in the same year Stevens succeeded in making similar treaties with the Flathead, the Kootenai, upper Pend d'Oreille, and the Blackfoot groups

The Indians generally were not satisfied with the reservation policy; some white men were killed and military attempts to punish the Yakimas were at first unsuccessful, a grave situation developed and 1855-1856 became a period of widespread unrest and hostility among the northwestern Indians Danger existed from California to British America and eastward as far as the Rocky Mountains Although the Nez Perce remained at peace, the majority of the Indians in the Columbia Basin were hostile The Indian population of Oregon and Washington territories at this time has been estimated at less than twenty-five thousand while the white population was probably over thirty thousand

Most of the fighting took place in southwestern Oregon, where Indian resistance was particularly obstinate, in the Puget Sound country, in the Yakima Valley, and at the Cascades on the Columbia Many communities west of the Cascade mountains built blockhouses as places of refuge At one time the Indians boldly attacked the little settlement of Seattle, but without success, and gradually the hostile tribesmen were brought under control

In 1858 the Spokane, Coeur d'Alene and Palouse Indians who had not been actively engaged in the war before defeated the Steptoe expedition, but were thoroughly subdued later in the same year by a larger and better organized force under the command of Colonel George Wright.

With the exception of the Modoc War (1872-1873) peace continued for nearly twenty years Then in 1877 the non-treaty Nez Perce, under Chief Joseph, went on the war path, and after worsting the troops in several encounters nearly succeeded in escaping into British terri-

tory. The first fighting occurred in central Idaho, and this was followed by Joseph's memorable retreat to Montana, where he was intercepted and captured by General Miles This retreat has always been regarded by military experts as a remarkable achievement In the following year, 1878, the Bannocks, a branch of the Shoshones, joined the Paiutes and carried on hostilities in southern Idaho and eastern Oregon

These Indian wars were expensive Among the costs must be reckoned the effects produced on the people who were living in or near the Indian country. They had good reason for their fears Frances Fuller Victor, author of *The Early Indian Wars of Oregon*, estimates from a compiled list that the average number of white people killed annually between 1850 and 1862 was one hundred and sixty The majority of the victims were not soldiers but isolated settlers, men working alone, small parties of immigrants, and travelers or prospectors in the Indian country For years constant apprehension of Indian danger hung over all outlying settlements.

Gold Mining in the Northwest

Gold was discovered in California in 1848, and in the years following prospectors worked through all the western territories examining the stream gravels and sands Placer deposits were found in the Colville country in 1855, and the influx of miners was one of the causes of the Indian wars in the period from 1855 to 1858 The Fraser River and Cariboo discoveries took thousands of American miners to British Columbia. The first discovery in Idaho was made in 1860 by Captain E. D. Pierce at Orofino Gold deposits were discovered in 1861 in the Salmon River valley, and the next year at Warrens and in the Boise Basin. At about the same time prospectors in western Montana found gold on Grasshopper Creek; in 1863 they discovered Alder Gulch, the greatest of Montana placers, and in 1864 Last Chance Gulch, where Helena now stands. It is estimated that the Pacific Northwest, excluding British Columbia, produced about $142,000,000 in placer gold during the early years.

The effect of gold mining was felt in many ways It was of great importance to the country during the Civil War because in an era of depreciated currency it provided the federal government with the foreign exchange necessary to buy the materials which could not be produced in this country. Towns grew up as a result of the demands of the mines for supplies of every kind. These towns were not usually in the vicinity of the mines but flourished because of the operations in

the mining areas Lewiston, Boise, Portland, and Walla Walla are examples. Later on, Seattle and Spokane were benefited by the development of mines within their regional trade areas. The wealth produced in the mines added to the capital resources and thus to the development of the Northwest Men disappointed as prospectors and miners became homesteaders and contributed to agricultural production Mines were a stimulus to transportation. Pack trains and freight wagons carried goods from river towns like Lewiston, Umatilla, and Wallula to the mines, the agricultural and grazing regions produced food and sent herds of cattle to the mining camps. It was a colorful and exciting period, invested with a romantic atmosphere which has given it an enduring interest to the present time.

Territories and States

Oregon territory, as the American portion of the Old Oregon country was called, was bounded on the east by the main range of the Rocky Mountains and included all the area now comprised in the three northwestern states, Oregon, Washington, Idaho, a considerable part of western Wyoming, and that portion of northwest Montana which is drained by the Clark Fork River Although President Polk urged Congress to take prompt action to create a territorial government for Oregon, the necessary legislation was not enacted until August, 1848. Joseph Lane was appointed the first territorial governor, arriving in Oregon to assume his duties on the last day of the Polk administration With Lane's arrival the provisional government which had functioned since 1843 went out of existence

No changes in the political geography were made until 1853, when the settlers living north of the Columbia secured a territorial organization of their own They had come to the conclusion that their interests would be better cared for if they were separated from the people living south of the Columbia No serious objection being offered by the Willamette Valley population, Washington Territory was added to the American political system with the Columbia River as its southern boundary as far as the forty-sixth parallel. From the point of intersection the boundary line followed this parallel eastward to the main range of the Rocky Mountains, then turned northward along the summit of the range to the international boundary.

Six years later, in 1859, Oregon was admitted to the Union with its present boundaries All that region between the Snake River and the Rocky Mountains that had been a part of Oregon Territory was cut off and attached to Washington Territory. Washington thus became a

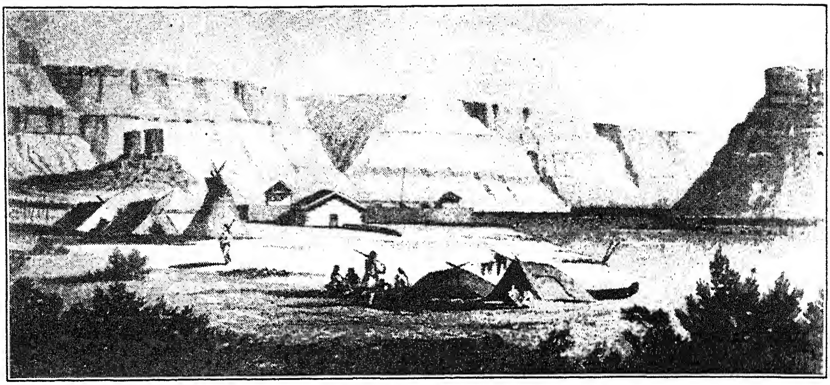


FIG. 5*A*. Old Fort Walla Walla in 1818.

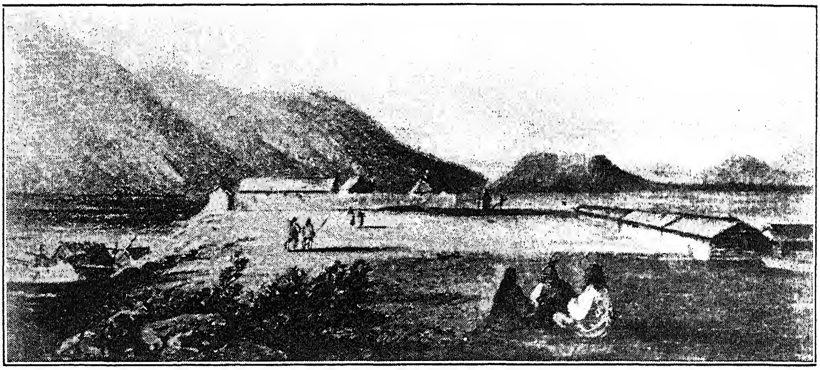


FIG. 5*B*. Fort Okanogan. Built in 1811 by the John Jacob Astor Company at the junction of the Okanogan and Columbia rivers.

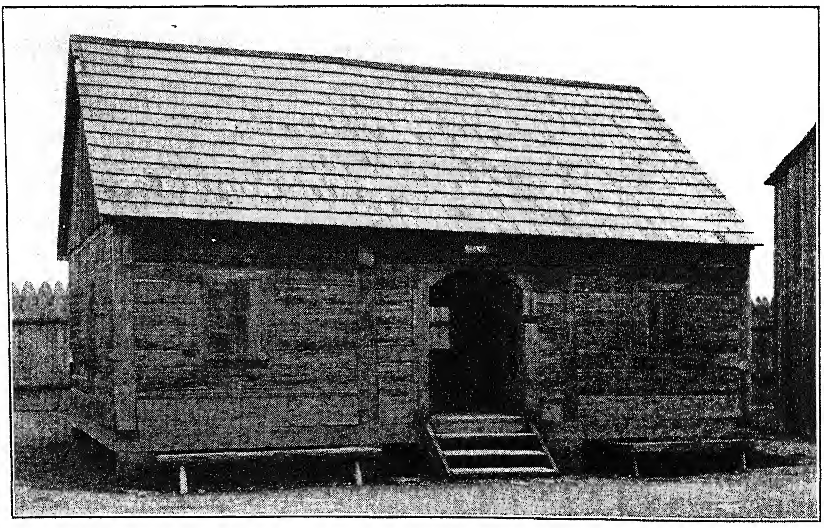


FIG. 5*C*. The oldest standing house in Washington, built in 1843 at Fort Nisqually

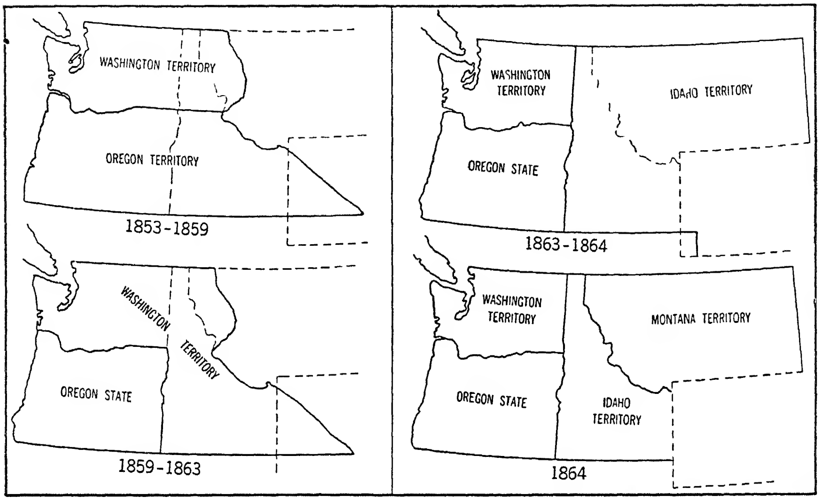


FIG 5D Territorial and state boundary changes in the Northwest.

huge unwieldy area extending a thousand miles from Puget Sound to South Pass in the Rocky Mountains In 1863 the miners in the Idaho gold fields wanted a territorial organization Thousands of men had flocked to the Clearwater, Salmon River, and Boise Basin diggings after the discovery of rich placer ground in 1860. Congress created Idaho Territory in 1863 with the western boundary which the state has today, and by this act the territory of Washington was reduced to the limits of the present state Idaho as it was organized in 1863 included not only the present state of Idaho, but also Montana and part of Wyoming However, in the following year, 1864, the territory of Montana was created, and the Idaho-Montana boundary established at that time left a narrow section between Montana and Washington—the so-called Idaho Panhandle

Washington remained a territory from 1853 to 1889 There was agitation for statehood long before its admission to the Union In 1878 a constitution was framed but, owing to the congressional political situation, Washington remained a territory until 1889, then Washington, Montana, and the two Dakotas were admitted to the Union and in the following year, 1890, Idaho also became a state.

The Railroad Era—The Great Migration

When the possibility of railroad extension to the Pacific Northwest was first considered, Puget Sound and the lower Columbia seemed to be natural outlets and terminal points. These areas also had the

largest populations and were eager for rail connections with the outside world. However, the first lines to make use of steam power were built in 1861 and 1862 at the portages of the Columbia River by the Oregon Steam Navigation Company, the principal carrier of freight and passengers on the river. Other railroad projects of a local character were planned, but lack of capital generally caused their suspension or failure. One successful enterprise was the narrow gauge railroad from Walla Walla to Wallula, promoted by Dr. Dorsey S. Baker and completed in 1875. It was later sold to the Oregon Railroad and Navigation Company.

Congress in 1853 authorized the war department to make surveys to the Pacific coast to determine the best route for a transcontinental railroad, but nothing on a considerable scale (aside from the surveys) was accomplished until after the Civil War. The central route with a terminus in California having been chosen, the Union Pacific and Central Pacific lines, connected in 1869, provided the first transcontinental railroad. In 1864, eleven years after Stevens' survey of the route, the Northern Pacific Company was chartered by Congress, and, like the Union and Central Pacific lines, it received a liberal land grant. The difficulty in securing the capital necessary to construct a transcontinental line through an almost uninhabited country, in the judgment of Congress, made the land-grant policy necessary. Construction began in 1870 and continued for three years until the panic of 1873 caused the failure of Jay Cooke and Company, financial agents of the Northern Pacific, and the suspension of work for several years. Work was started again in 1879, and the main line was finished in 1883 although the Cascade division was not completed until 1887.

In the same period the Oregon Railroad and Navigation Company built a line up the Columbia and through eastern Oregon to Huntington, where it connected with the Oregon Short Line, a subsidiary of the Union Pacific. The name of Henry Villard will be remembered in connection with the Oregon Railroad and Navigation and the Northern Pacific, as will that of James J. Hill with the Great Northern, which was completed to the coast in 1893. Oregon and California were connected by rail in 1887. The last great railroad to cross the Northwest to salt water was the Chicago, Milwaukee, St Paul and Pacific (the Milwaukee), which was finished in 1909.

During the period after the building of the main lines, numerous feeder lines were constructed to serve the outlying productive areas.

The combined population of the three northwestern states, Oregon, Washington, and Idaho, was 282,494 in 1880, when the period of rail-

road building was beginning In 1910, when it was virtually completed, the population of the same three states had grown to 2,140,349 In thirty years the number of inhabitants had increased seven and a half times. For this great migration—a migration in which people from every state and many foreign countries took part and which continued for more than a generation—the railroads were mainly responsible.

When railroad building ceased the Northwest was ready to enter a new era. The country had been explored, its political sovereignty had been decided, despite regrettable incidents, the relations of the whites with the Indians had been adjusted, the better agricultural, mineral, and forest lands had largely passed into private ownership, great cities had grown up and the growth in population had multiplied property valuations enormously. With the new era was to come a slower growth, the conservation and more intensive use of natural resources, great expansion in the utilization of power, new forms of transportation, the development of manufacturing opportunities, a higher degree of technical skill in many fields of production; and an ever-increasing interest in the cultural elements of life.

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PART II

THE PHYSICAL ENVIRONMENT

CHAPTER 3

PHYSICAL FRAMEWORK OF THE NORTHWEST
GEOLOGY AND GEOMORPHOLOGY OF THE REGION WEST OF THE CASCADE MOUNTAINS

SECTION 1

By Warren D. Smith

The great mountain barrier of the Cascades divides the Pacific Northwest into two markedly different sections The western section is characterized by marine sedimentary rocks and has a marine climate, but east to the Rockies are igneous rocks, chiefly Tertiary lavas, and a continental climate

Because of these basic physical facts, the life and activities in the two sections are fundamentally different For this reason it would have been more logical to have included western Oregon and western Washington in one state and that portion of the two states east of the Cascades in another. The Columbia River, which is now a boundary between two areas naturally belonging together, should have been a connecting link between the two, and if the Region were being divided into states today different dividing lines might be drawn.

A detailed examination of the area as a whole shows considerable variation in terrain and climate, which permits separation into smaller natural units for convenience and description. The western section can be divided into the following major physiographic provinces [1]

1 The Olympic Mountains
2 The Coast Range
3 The Klamath Mountains
4 Willamette-Puget Trough
5 The Cascade Mountains

The Oregon Coast Range continues across the Columbia into south-

[1] The layman should understand that this term has no political significance

western Washington as far north as the Chehalis Valley, which serves as a convenient boundary, with the Olympic Mountains rising north of Grays Harbor and the Chehalis River That part of the Coast Range in Washington, called the Willapa Hills, consists of an eroded dome-shaped structure from which stream valleys radiate, in contrast to the usual ridge and valley pattern more common to the Coast Range proper Although some students of Washington physiography have considered the Willapa Hills a separate geomorphologic unit, it seems best to include them with the rest of the Coast Range because of their small size.

The rocks in the western section are dominantly sedimentary[2] and of marine origin, although representatives of metamorphic and igneous groups are found here. A geologic column (page 58) that gives the characteristics of the rocks formed in different geological periods has been prepared by E. T Hodge, who also drew a generalized geologic map, Fig. 58.

The aspect of any particular terrain depends upon three things: (1) structure, (2) process, (3) stage; that is to say, the kind and arrangement (attitude) of the materials, the agents by which it is being modified, including water erosion, vulcanism, glaciation, etc , and last, how far has the action proceeded, whether it is in a youthful, mature, or old-age stage? For example, the Columbia Lava Plateau is made up of nearly flat lying lava flows (somewhat folded and faulted in places), being modified by both water and wind erosion and in a youthful stage. The Willamette Valley, on the other hand, is made up of alluvial river detritus and some glacial outwash, being modified by a river in an old-age stage. As a result we have two radically different types of terrain, resulting in highly different human activities.

In order to gain a better understanding of the development of surface features by erosion processes, a brief discussion of the climate is

[2] For the benefit of the reader who may not have acquired much knowledge of geology, the following definitions are given The three main groups of rocks are (1) *igneous* (literally fire-born) that were once molten, like the coarse crystalline granite and granodiorite, and the surface lavas, basalt and andesite, (2) *sedimentary* or deposited materials (by water, ice, and wind), like sandstone, shale, limestone, and coal, and (3) *metamorphic* rocks, those that have been altered from their original condition, generally by heat and pressure, like marble (from limestone), slate (from shale), quartzite (from sandstone), and argillite (from sandy shale) Gneiss and schist are names given to the most highly metamorphosed rocks that were originally either igneous or sedimentary The principal geological agents or processes operating to form and modify these rocks, and consequently alter the face of the earth, are erosion and deposition, glaciation, vulcanism, and diastrophism (movements of the earth's crust).

desirable. A more complete treatment of climate is found in a separate chapter.

The Pacific Northwest lies, in its western part at least, within the domain of the westerly winds and is influenced by its position near the Pacific Ocean. Winter rains, dry summers, and a moderate range of temperature characterize the Region. With great regularity during about eight months of the year, cyclonic storms move in from the ocean and bring copious rains. The warm moisture-laden winds from the Pacific blow across the Coast Ranges and the Cascades, and drop

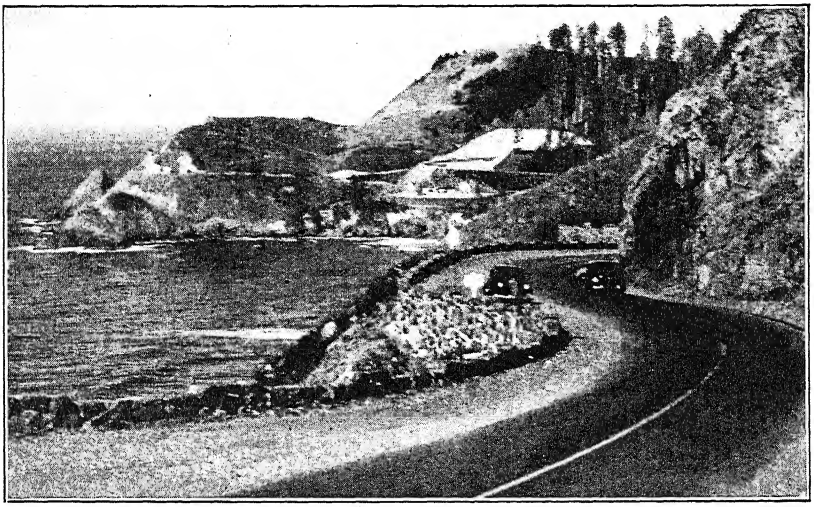


FIG. 6. Hecata Head, Oregon Coast, showing terraces and culture along a scenic ocean frontage. (*Photograph by Eddy.*)

most of their moisture on the windward slopes. On the lee side of the mountains there is a resultant decreased precipitation, which east of the Cascades results in a "rain shadow" area of semidesert conditions. Precipitation varies from 100 to 200 inches in the mountains to about 6 inches in some parts of the Columbia Plateau east of the Cascades. This has resulted in the growth of heavy fir (Douglas fir) forests on the western side of the Cascade barrier, which changes very abruptly to pine (ponderosa) on the eastern side. As one goes still farther eastward, the pine forest gives way to steppe land and open ranges. Hence correspondingly great differences in the amount of runoff and the effects of agents of erosion occur from the humid coasts across the mountains into the deserts.

PACIFIC COASTAL REGIONS

1. Olympic Mountains (Northwestern Washington)

These mountains constitute a definite physiographic unit, a cluster of peaks extending up to 7,954 feet, with associated radiating ridges, often of a knife-edge narrowness. The mountains are carved out of rocks ranging from the Cretaceous, probably through the Tertiary, some of them metamorphics. They stand completely isolated from the rest of the mountains of the state. The drainage pattern of these moun-

FIG. 7. Mount Olympus from the east. (*Photograph by Glover.*)

tains is generally radial, proof that the Olympics are eroded from a dome-shaped uplift. They are very rugged and wild in appearance and in every way quite primitive. Because of excessive rainfall the mountains are covered with almost junglelike vegetation. The fact that the bedrock is generally of a hard, resistant nature causes the canyon slopes to maintain their steepness in spite of the heavy rainfall and vigorous runoff. According to Weaver[3] these mountains have a peneplain-like surface at about 5,000 feet altitude, above which rise Mt. Olympus, Mt. Angelés, Mt. Eleanor, Mt. Church, and other residual peaks.

The geologic column of the Olympic Mountains consists of meta-

[3] C. E. Weaver, *Washington Geological Survey Bulletin* 13.

morphic and volcanic rocks at the base and then 1,500 feet of sediments Then after a period of volcanic flows and tuffs between 5,000 and 6,000 feet of sediments were deposited As mentioned, most of these rocks are resistant to erosion

Extensive Alpine glaciation occurred in the Olympics during the Pleistocene, as indicated by cirque amphitheaters and U-shaped valleys, and extensive glacial outwash on the lowlands at the foot of the mountains

The Olympic Mountains, owing to their very rugged topography and dense vegetation on the lower slopes, are very sparsely settled Manganese deposits have been discovered, but as yet production has not been significant Because of their great scenic value a new National Park that includes the main mass of the mountains has recently been created.

2. The Coast Ranges

The Coast Ranges of the Pacific Northwest include the mountains of Vancouver Island and the mainland of British Columbia, the Olympic Mountains in Washington, and the Coast Range in Oregon, but in this chapter each of them is described separately Under the heading, the Coast Range, only the Coast mountains and hills south of the Olympic Mountains down to the Coquille River in Oregon will be included, because of similar geomorphology and geologic age

The Coast Range is a broad and low upfold, consisting dominantly of folded and slightly faulted Tertiary marine sediments with some volcanic intrusions These mountains differ markedly from the Olympics to the north and the Klamaths to the south in having no metamorphic rocks, and the resistance of the bedrock to erosion is therefore generally weaker

This range, in Oregon at least, is bordered on the west by the Pacific Ocean without any appreciable coastal plain, at the most three to five miles wide, but in Washington it expands at Grays Harbor to a width of thirty miles On the east the Coast Range slopes for the most part rather gradually down to the Willamette and Cowlitz valleys. On the coastal side the mouths of the river valleys were drowned at the close of the glacial period, and barrier beaches, built by waves and currents, protect the bays from storms. Examples are Grays Harbor and Willapa Bay in Washington and Tillamook Bay and Coos Bay in Oregon The sandy barrier beaches have now become summer playgrounds.

The transverse valleys in this region are fairly steep walled, and the rivers swing in great curves, suggesting incised meanders. A cross-

section of some of these valleys shows a valley-in-valley profile with remnants of a generally rolling upland surface. Peneplanation with subsequent uplift and rejuvenation of streams is the probable explanation of these conditions, which resemble those of Fig. 9.

The highest elevation in the Oregon Coast Range is Mary's Peak, 4,097 feet, an intrusive mass of diabase and gabbro.

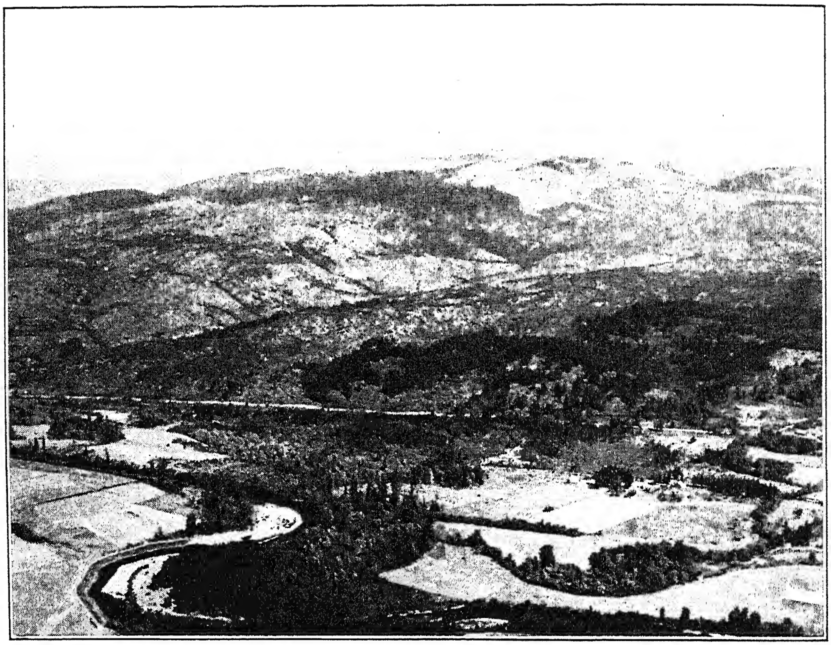


FIG. 8. Willapa Hills, a part of the Coast Range in southwestern Washington. The photograph shows staggered logging. (*Photograph by 41st Div. Aviation, Washington National Guard.*)

To the south there is a connection across to the Cascades, called the Calapooya Mountains, that encloses the Willamette Valley on the south and separates its drainage from that of the Umpqua River which flows from the Cascades west to the Pacific. Around Roseburg, the Umpqua Valley broadens, and on the level terraces and fertile slopes an excellent fruit and general farming area has been developed.

Farther north in British Columbia the Coast Ranges of Oregon and Washington are continued as islands off the British Columbia coast. The rocks are even older in some instances than those to the south and the topography even more rugged. This island infested coast may be considered most simply as a drowned mountain range where the sea

has submerged the cross valleys, forming deep channels The features of British Columbia are described separately later.

There are many breaks in the continuity of the Coast Range which have provided natural routes for railroads and highways Some of these transverse valleys are due to structural features, cross-folding, and perhaps some faulting, others are due to erosion by transverse streams, antecedent to the uplift of the mountains Some of these valleys go all the way across the range to the sea, like the valleys of the Columbia, the Chehalis, and the Umpqua, others, like the Siuslaw, Yaquina, and Nehalem, run only as far as the crest.

The Willapa Hills in southwestern Washington are eroded from a flattish dome structure affecting predominantly sedimentary rocks, and they have an average elevation of about 500 feet, with higher points up to 3,000 feet.

3. Klamath Mountains

South of the Coast Range in Oregon, the Klamath Mountains, a complex system of subsidiary ranges, are formed from old Mesozoic rocks, metamorphics, and sediments This region was extensively peneplained and subsequently elevated The accordant ridge tops have a general elevation of 4,500-5,000 feet with a few monadnocks up to 7,000-8,000 feet.

The Klamath Mountains extend eastward, merge almost imperceptibly with the Cascades, and enclose the northern end of the Great Valley of California Two transverse streams, the Rogue in Oregon and the Klamath in California, have carved deep gorges from east to west all the way to the sea Some of the finest scenery in Oregon is found in the Canyon of the Rogue, over 2,000 feet in depth and through which neither highway nor railroad has yet been built Since the rocks are resistant to erosion, the slopes of the Klamaths are often so steep that it has been found impracticable to locate the roads in the valleys, and they are obliged to follow the ridge tops. This is particularly true in Curry County in southwestern Oregon, one of the most rugged parts of the entire state.

One outstanding feature of this region is the broad valley of the Rogue in the vicinity of Medford and Grants Pass. When irrigated, this is very fertile and specializes in the production of pears and peaches. W B. Merriam[4] has called attention to the rather peculiar

[4] Climate of the Rogue River Valley, Oregon, *Monthly Weather Review LXIV*, 1936.

climatic conditions of this part of the Rogue with semi-arid conditions induced by the so-called California High just south of it. The climate is transitional between California and the Willamette Valley, making the district distinct in climate from other parts of southwestern Oregon.

The structure of the rocks in the Klamath region is generally complex. An extensive intrusive mass of granodiorite, known as the Siskiyou batholith, is bordered by Mesozoic sediments which stand at high angles. There are also smaller and more basic intrusions of peridotite and peroxenite, in part altered to serpentine, and occasionally containing chromite deposits. A cross-section, taken from *U. S. Geological Survey Bulletin* 196 (Diller, 1902), shows the general structure of the older formations and their relations to the later Cascade lavas (Fig. 9).

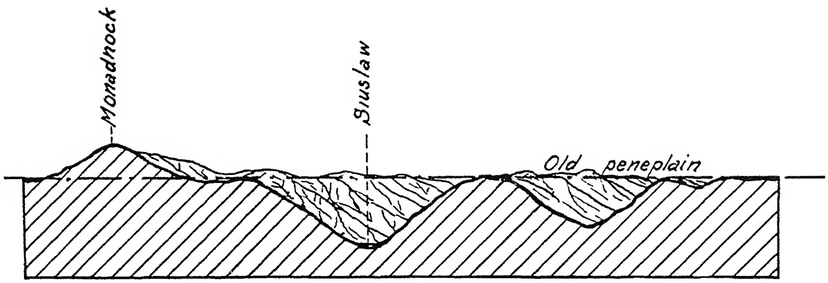


FIG. 9. Cross-section in southwestern Oregon showing old peneplain surface

The mineral resources of this subregion are gold, both lode and placer, chromite, manganese, copper, and some platinum. Other resources of the region are lumber in the upland areas and orchards in the sheltered valleys. Some parts of the Klamath Mountains are among the most inaccessible in the Northwest.[5]

The general description just given relating to the Klamath Mountains applies fairly well to the northwestern part of California. The same types of formations and similar geomorphologic features are to be found well to the southward below the Klamath River. Furthermore, the Cascade Range also continues into California as far as the topographic and geologic break just south of Lassen Peak. Therefore a strip of California from about latitude 41 degrees northward may be considered both on geomorphologic and geographic grounds to form a part of the Pacific Northwest.

[5] The book, *Honey in the Horn*, by Harold L. Davis, describes some of the isolated Klamaths.

The Oregon and Washington Coasts

The shore line in Oregon and Washington north to the Strait of Juan de Fuca is not indented to the same degree as the shore of Puget Sound and the British Columbia and southeastern Alaskan coasts. It appears that elevation has been more recent in the southern part whereas submergence has been the rule in the northern part The Columbia is drowned for 140 miles, and the Chehalis, Willapa, Umpqua, and Coquille rivers each for 25-30 miles In Oregon there is a very striking change in the shore line south of the Coquille River, owing largely to the change from softer to harder rocks The headlands are generally due to basaltic masses or other resistant rocks whereas the large bays are usually in softer rocks.

A special and significant feature of the coast is the terraces Near Cape Ferrelo (southwestern Oregon) a number of narrow wave-cut platforms are found at approximately: 40, 100, 220, 500, 1,000, 1,500 feet elevation above the sea. The Coast Highway for many miles in Oregon is located on one or the other of the lower terraces

The harbors along the Oregon and Washington coasts are, with one or two exceptions, rather inferior, owing to shallow water Submergence during an earlier geographic cycle caused embayments, but more recent elevation of much of the coast line, together with silting, has decreased their depths Long barrier beaches and sand spits afford protection from the open sea Changes in the shore line are continually taking place. One such recent change in Oregon has led to serious consequences During heavy storms in 1939 the long spit across Tillamook Bay was cut through in four places by the pounding sea, directly menacing the resort of Bay Ocean, located on the spit, and indirectly threatening the oyster industry within Tillamook Bay.

This coastal plain has the following industries (1) port activities, (2) lumber and other wood-product manufactures, (3) fishing, (4) resort centers for tourists, (5) dairying, (6) certain specialty crops such as cranberries, (7) oyster growing, and (8) salmon canneries The completion of the fine, paved Coast Highway and of big bridges across the river mouths in Oregon has greatly stimulated tourism A special recreational attraction consists of sand-blocked lakes formed in old stream valleys by shifting dunes These are ideal for summer homes and sport fishing. Siltcoos in Lane County, Oregon, is one of the finest examples

The narrow coastal plain of Oregon, with its numerous dunes, supports comparatively few permanent residents although it is a summer resort of increasing importance Debouching onto the narrow lowland are numerous shoestring valleys with dairy farms where soil conditions

are favorable. The towns are chiefly lumber-sawing centers. In the Coast Range the terrain is, for the most part, rugged and densely forested. Lumbering is the chief industry, the bulk of the timber going to the coast or to the Willamette Valley by truck for manufacturing. Mineral exploitation is limited to construction materials such as sandstone, gravel, and crushed rock, with some coal near Marshfield.

4. Willamette-Puget Trough

Between the Coast Range and the Cascades and lying north of the Klamath Mountains is the great structural depression of the Puget-Willamette Trough. This subregion is underlain by Tertiary sediments which dip generally in an easterly direction until they disappear beneath the Miocene and later lavas of the Cascades. In both Oregon and Washington, however, these Tertiary marine sediments are in turn overlaid by deposits of river detritus and glacial outwash of varying thicknesses. The northern part of this trough is partially submerged beneath the waters of Puget Sound and extends only for a short distance into Canada beyond the Fraser River. The middle portion is drained by the Chehalis River into Grays Harbor and by the narrow valley of the Cowlitz into the Columbia River. The southern part includes the wide and fertile Willamette Valley of Oregon.

The Puget Sound region is marked by extensive glacial gravels of the Admiralty and Vashon epochs,[6] and the underlying bed rock is rarely seen in road cuts. Numerous morainal dammed lakes like Washington and Whatcom and steep hills like those of Seattle resulted from the glaciation. The huge glacier that moved south from Canada scooped out the valley floors of ancient "Puget Sound" and its tributaries, leaving the interfluves to become the ramifying peninsulas and islands of Puget Sound when this area was flooded by the sea after the melting of the glacial ice. This made the splendid deep bays and harbors that determine the location of Seattle, Tacoma, Bellingham and other seaport cities.

In the regions south of Camp Lewis and extending down to Tenino, Washington, there is an extensive outwash gravel plain with small and nearly circular mounds making a characteristic topographic appearance. Many hypotheses have been advanced to explain these peculiar mounds which have been reviewed fully by Bretz.[6] Most geologists who have studied the area think that the mounds are features of glacial outwash, but there is not yet complete agreement as to the details of formation.

[6] J Harlen Bretz, "Glaciation in the Puget Sound Region," *Washington Geological Survey Bulletin* 8.

The Willamette Valley is broad and generally flat in the southern portion, owing to lateral planation by the river. The central portion is more rugged and constricted owing to much basalt, probably older than the Cascade lavas, and certainly older than the later andesitic lavas of that range Part of the Willamette is very meandering with numerous braided channels.

During the Pleistocene, the then large Cascade glaciers and resulting meltwaters deposited gravels and silt in the Willamette Valley, chiefly on the eastern border, and during an extensive flooding of the lowlands (probably due to an ice-jam in the Columbia) many erratic boulders were ice rafted into the valley and dumped here and there. "The topographic and stratigraphic relations of these deposits indicate stages of alluviation separated by stages of valley deepening, that may be tentatively correlated with stages in the Mississippi Valley from Kansan to recent"[7]

The meanderings of the Willamette River in the southern portions of the valley have caused considerable destruction of farm land. Occasional disastrous floods (1861, 1890, and 1927) have resulted in the federal government's starting an extensive program of flood control, the Willamette Valley Project. This program includes the building of seven dams on the tributaries of the upper part of the river, revetment, and straightening of portions of the river

Important topographic features of the Willamette Valley are the buttes, made up of hard cores of basalt and in part veneered by sediments The highest of these is Spencer's Butte, 2,065 feet, about five miles south of Eugene The geological cross-section of the Willamette Valley, together with the chief soil types, is shown in Fig 10.

A special feature of the geology of the upper Willamette Valley is the so-called Goshen Flora found in terrestial upper Oligocene beds. This flora is tropical, showing affinities with trees now growing in Panama and the Philippines

The Willamette Valley The diversity of underlying geological conditions has helped produce a variety of soils (Fig 10) This in turn, combined with favorable climatic conditions, insures a diversified type of agriculture, in fact, in this region, practically every type of farming system practiced in the Northwest can be observed The principal industries are orchards, small fruits, and dairying The farming areas in the western part of Washington are generally smaller than those in the Willamette Valley, because of the topography, and in many places in

[7] Ira S Allison, *Bulletin of the Geological Society*, Vol 51, No 12, Part 2, p 2016, 1940

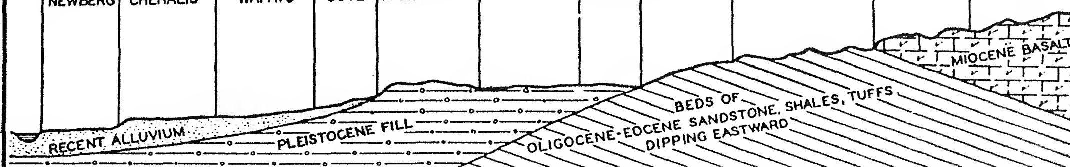
TOPOGRAPHY	FLOOD PLAIN				MAIN VALLEY FLOOR			HILL LAND			
MAJOR SOIL GROUPS	RECENT ALLUVIAL SOILS (14 %)				OLD VALLEY FILLING SOILS (22 %)			RESIDUAL SOILS (64 %)			
REPRESENTATIVE SOIL SERIES	NEWBERG	CHEHALIS	WAPATO	COVE	WILLAMETTE	AMITY	DAYTON	CARLTON	MELBOURNE	OLYMPIC	AIKEN
GEOLOGIC STRUCTURE											
DERIVED FROM	SEDIMENTARY AND IGNEOUS ROCKS							SEDIMENTARY		BASALT	
COLOR OF TOP SOIL	BROWN	BROWN	DARK TO GRAY BROWN	BROWN TO BLACK	BROWN	GRAYISH BROWN	LIGHT BROWN TO GRAY	YELLOWISH BROWN	BROWN TO DARK BROWN	BROWN TO REDDISH BROWN	REDDISH BROWN TO RED
AREA IN 1000 ACRES	99	219	203	30	352	278	183	77	378	223	283
% IMPROVED	60	80	50	60	90	85	70	80	70	80	70
DRAINAGE	GOOD	GOOD	POOR	POOR	GOOD	RESTRICTED	POOR	FAIR	GOOD	GOOD	GOOD
ADDITIONAL DATA	FIRST BOTTOM LANDS	SECOND BOTTOM LANDS (IRRIGABLE)	FAIR IRRIGABILITY	STICKY	SLIGHTLY UNDULATING LANDS (IRRIGABLE)	HALF WHITE LANDS. FAIR IRRIGABILITY.	WHITE LANDS	LOW SLOPES	ASSOCIATED WITH REDDISH BROWN SITES SERIES	FRIABLE STRUCTURE. WALDO HILLS	WELL ADAPTED TO NUTS AND STONE FRUITS

FIG. 10. Key to major soil types in Willamette Valley. (*Oregon State Planning Board.*)

Washington the farms are restricted to delta regions, lake beds, and river bottoms. Minerals are limited to construction and ceramic materials.

The menace from floods is always present in western Washington and Oregon. Owing to the temporary base level condition of the Willamette River, much undrained land exists. Owing to the summer drouth of nearly three months, irrigation is on the increase for certain crops.

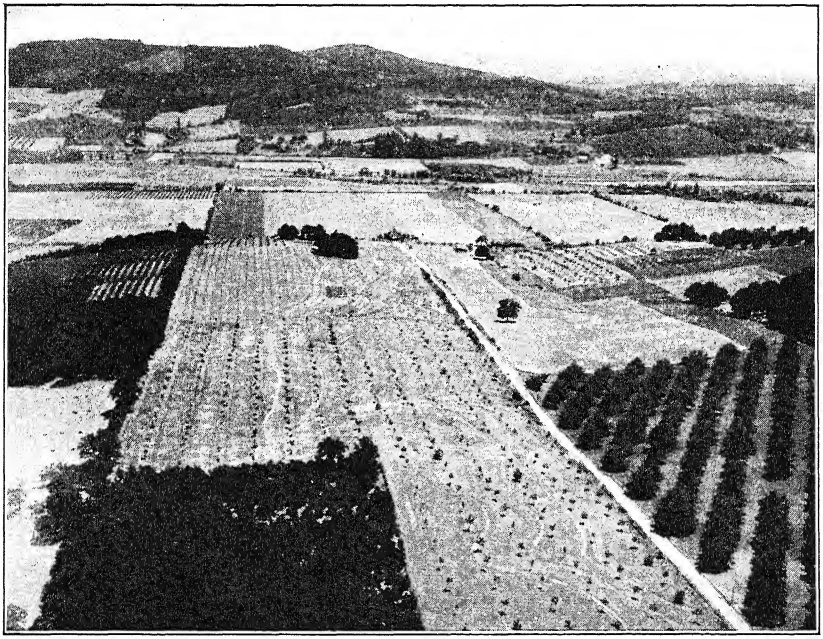


FIG. 11. The Willamette Valley near Newberg. Note the intensive land use of this fertile region. The orchards are walnuts, prunes, and filberts. Nearly all kinds of farm systems are practiced here. (*Photograph by Soil Conservation Service.*)

5. The Cascades

These mountains in Oregon and their southern half in Washington may be thought of as a high western portion of the great lava plateau which extends eastward across the states of Washington and Oregon into Idaho. Above their undulating surface the Cascades are surmounted by a line of young volcanic peaks, the highest of which are Rainier (14,420 feet), and Adams (12,307 feet) with several others that exceed 10,000 feet in elevation. The Pacific Coast Range of Canada is essentially an extension northward into Alaska of the Cascade Range,

but these mountains consist mainly of granite and other old rocks throughout their extent in British Columbia, except for some recent volcanoes north of Vancouver. Not until Alaska is reached do volcanic peaks again become numerous.

Volcanic cones in all stages of dissection can be seen in the Cascade Range from the nearly perfect and young cones of Mt. St. Helens and the South Sister to the completely beheaded one of Mt. Mazama

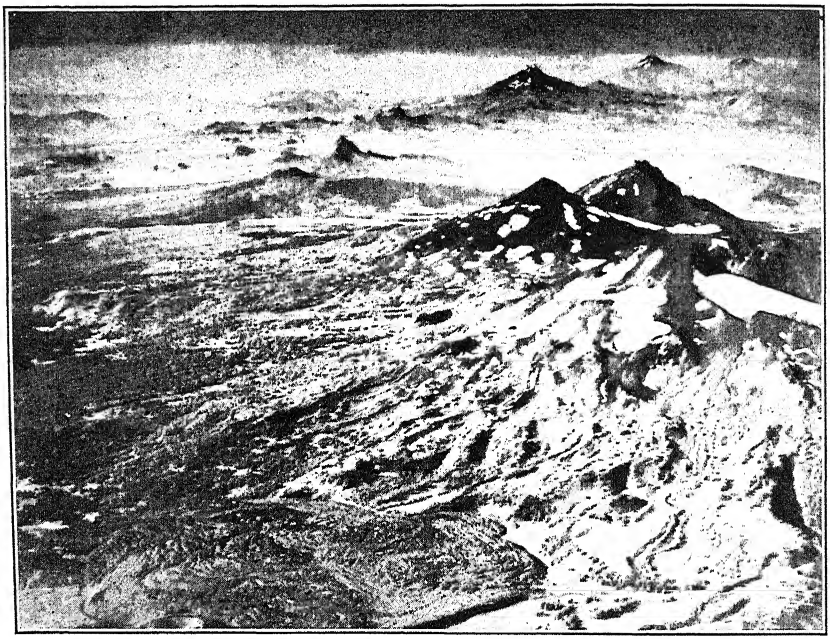


FIG. 12. Aerial view of Cascades looking north with the Three Sisters in the foreground. (*U.S. Army Air Corps.*)

(Crater Lake). The only known active volcano within the forty-eight states is Lassen Peak in the Cascades of northern California. Mt. Rainier, Crater Lake, and Lassen Peak are all National Parks. Of them Mt. Rainier is best supplied with glaciers; in fact, of the mountains belonging to the United States outside of Alaska, it is perhaps best for the study of active glaciation. The largest glacier in Oregon is Collier Glacier, about one and a half miles long, lying between the North and Middle Sisters. Important snow-capped volcanic peaks of Oregon include Mt. Hood, Mt. Jefferson, Mt. Washington, the Three Sisters, Mt. Thielson, and Mt. Pitt. In Washington are Adams, St. Helens, Baker, and Glacier Peak. Mt. Shasta in northern California may also

be included with the "snow sentinels" of the Cascades, as may be Mt. Garibaldi in British Columbia.

The crowning scenic feature of the Cascades, and one of the most puzzling geological problems, is Crater Lake On the site of the present lake once rose a lordly peak of the proportions of Shasta today. Somewhere between 5,000 and 10,000 years ago this mountain was wrecked; some geologists believe by engulfment, others by explosion, and still others subscribe to a combination of these two [8] One of the most interesting discoveries with reference to this mountain is the finding of artifacts of early man and perhaps human skeletal remains in eastern Oregon beneath pumice from this old volcano.[9]

There is a fairly uniform plateau surface on the summit of the Cascades, both of Washington and of Oregon, which from a distance presents the appearance of a peneplain. Early geologists studying this surface in Washington explained its general level character as due to peneplanation Among later geologists, there is some divergence from this view, and the surface is now generally considered to be of structural origin and not a peneplain.

In the northern half of the Washington Cascades, there is much more intrusive rock, granodiorite, in evidence at the surface than farther south. Crossing over the Cascades in Washington, via Snoqualmie Pass or Stevens Pass, we can observe great exposures of this important intrusive mass of coarse-textured igneous rock, whereas in the Oregon section there is scarcely any of it. On every side in Oregon there are thousands of feet of basaltic and andesitic lavas Occasional exposures of granitic-textured rocks in the deeper canyons indicate that the geological history of the range in both the north and the south has been essentially the same However, the northern portion of the Cascades in Washington contains sediments and metamorphic rocks related to rocks exposed in the Rocky Mountains to the east and the San Juan Islands to the west, suggesting that this part of the Cascades may have an older history than the rest of the range to the south. Some parts of the mountains have been built up by lava flows superimposed one upon another without much uplift of the volcanic rocks. However, generally, the Cascades are composite mountains due to folding, with some faulting, of Tertiary lavas probably derived from a great intrusive beneath, and the whole mass dissected and modified by water and ice erosion.

[8] Howell Williams, "Calderas and Their Origin," University of California Publications, *Bulletin* 6, pp 269-277, Berkeley, 1941.

[9] L S Cressman, "Early Man in Oregon," University of Oregon Monograph, *Studies in Anthropology*, No. 3 (1940).

On the western side, the Cascades rise gradually from the Willamette-Cowlitz Valley floor to the crest of the range, with long stream valleys carrying rivers of considerable size. The summit of the Cascades is situated much nearer the eastern side, and this eastern margin is much more abrupt in places than the western edge. An example of this is in the Klamath Falls section of Oregon, where pronounced north-south

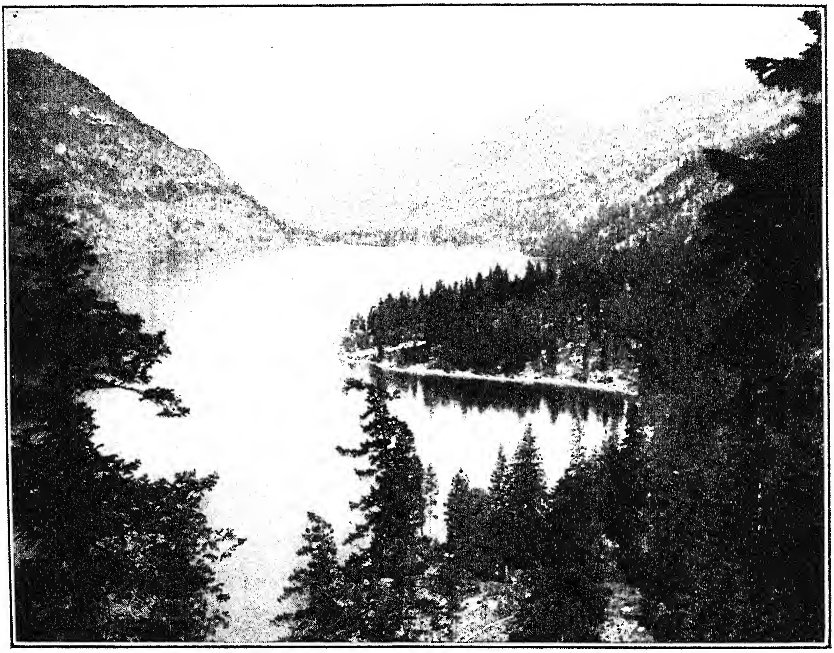


FIG. 13. Head of Lake Chelan. (*Photograph by Lindsley.*)

fault scarps occur. Owing to the proximity to the basins and plateaus in eastern Oregon and Washington and to the rain shadow effect of the mountains, the eastward flowing streams from the Cascades are usually smaller than the western ones. There is a marked difference in cross-section as one ascends the valleys worn by Cascade streams. In their lower courses they are rather steep walled and decidedly V-shaped. Nearer the summit of the range they are wider and decidedly U-shaped, ending in distinct cirque amphitheaters as a result of extensive glaciation. By their characteristic headward erosion the mountain glaciers that once occupied the cirques lowered the divide between opposite valleys, thereby forming the passes over which the railroads, highways, and trails have been built. Many lakes resulted from the glaciation, of

which Lake Chelan, 60 miles long and 1,500 feet deep, is the most remarkable.

• Bisecting the Pacific Northwest is the Columbia, the major river of western America Formerly, the Columbia Gorge was referred to as an antecedent stream, that is, one which developed its course during an earlier geologic cycle and has maintained this across the slowly rising Cascade and Coast Range barriers Recent work, particularly by E. T Hodge,[10] seems to point to a different history—one involving superimposition and faulting The gorge provides a natural defile through the Cascades to the interior Columbia Basin

The economic deposits of the Cascades include basalt and andesite, used for road metal, gold and silver in quartz veins, lead, zinc, and some copper and quicksilver. Mining districts in this province in Oregon are Quartzville, North Santiam, Blue River, and Bohemia for gold and silver, Clackamas, Black Butte, and Tiller for quicksilver The presence nearer the surface in the northern Cascades of plutonic rock as contrasted with the region farther south in Oregon has resulted in greater mining activity in the former The following important mining districts in northern Washington should be mentioned Holden (copper and gold) in the Lake Chelan country, Index in Snohomish County, and several gold properties in Okanogan County Farther south Morton in Lewis County is important for quicksilver

Besides the mineral deposits, other economic products and uses of this region are of course lumber and grazing in the meadows of the mountain valleys and in the high-level meadows. Numerous hot springs have caused the establishment of several resorts Much use is made of the mountains for recreation both in summer and winter The Cascades are exceedingly rugged and are dissected by large streams which can furnish large quantities of hydroelectric energy Only the Columbia, however, is available for transportation.

[10] E T Hodge, "Columbia River Fault," *Bulletin of the Geological Society*, Vol 42, pp 923-984

Prepared by E. T. Hodge

Eras	Periods	Events	Types of Life		Orogenic Times	Mineralization
Cenozoic	Quaternary	Glaciation Alpine glaciation, no marine sediments Volcanics mainly restricted to Cascade belt	Modern Seed Plants (Angiosperms)	Age of Man	Cascadian Revolution	Salines in E Oregon and Washington Road metal Gold placers
	Tertiary	Rocky Mts and other western mountains Lacustrine basin deposits east of Cascades Continental sediments in central Cascade belt Marine sediments restricted to west side Great lava flows		Age of Mammals	Laramide Revolution	Diatomite in E Oregon and Washington Tertiary coal in Washington, Oregon, Montana Quicksilver deposits of Oregon Washington and Idaho Butte, Montana Coeur d'Alene Idaho Republic Washington Silver City Idaho etc
Menozoic	Cretaceous Jurassic Triassic	Rocky Mts Transgression of Cretaceous seas Intrusion of granodiorite batholith Volcanics In general, Mesozoic marine sediments and volcanics west of Cascades Continental sediments and minor volcanics east of Cascades	Modern Seed Plants (Angiosperms) Gymnosperms	Age of Reptiles and Ammonites	Nevadan Revolution Appalachian Revolution	Coal on Vancouver Island and central Montana N E and S W Oregon Northern Cascade U S Washington, Southern B C Black Marble in Oregon Crystalline limestone used for cement
Paleozoic	Permian Pennsylvanian Mississippian	Undifferentiated carboniferous with volcanics	Age of Spore-Bearing Flora	Age of Amphibians		Phosphate in S E Idaho and east Montana Magnesite in N E Washington Limestone for cement
	Devonian Silurian Ordovician Cambrian	Represented by highly metamorphosed rocks with intricate structure Commonly recognized as Cambrian-Ordovician and younger, or Carboniferous and older		Age of Fishes Age of Marine Invertebrates	Penokean Revolution	
Proterozoic		Belt Series	Age of Marine Floras	Primitive Marine Invertebrates	Algoman Revolution	
Archeozoic		Shuswap Series		Limestone-graptolitic Indications of life		

SECTION 2

COLUMBIA LAVA BASINS AND PLATEAUS

By Otis W. Freeman

One of the largest areas of volcanic rock on the earth's surface, covering more than 200,000 square miles, is located in the Pacific Northwest Since much of this area is drained by the Columbia River and its tributaries, it has been generally spoken of as the "Columbia Plateau," although really not a plateau at all, but rather an intermountain region between the Cascades and northern Rocky Mountains Most of the so-called Columbia Plateau is upland with elevations of 1,000 to 5,000 or more feet above sea level, but some of the surface consists of basins only a few hundred feet in elevation and mountains are included that reach elevations of nearly 10,000 feet The region is far from having the uniform surface generally considered a requirement for a plateau, but instead possesses a highly varied surface of small plateaus, both level and tilted, of hills, eroded slopes, high rugged mountains, broad valleys and basins, anticlinal ridges, and flat plains Moreover, instead of rising abruptly on at least one side as plateaus are said to do, the area is enclosed by mountains on the west, north, and east, and grades almost imperceptibly into the Basin and Range Province to the south Since the entire province is dominantly underlain by basaltic lava flows that were later warped downward into basins and upward to form plateaus, the name Columbia Lava Basins and Plateaus was selected [1]

After an earlier period of eruption characterized by light-colored (acid) lava, mainly andesite and rhyolite, there were numerous extensive flows of dark-colored basalt

Especially in the northern half of the region, volcanic vents are

[1] Fenneman in *Physiography of the Western United States* divided the Columbia Plateau into five sections Walla Walla, Blue Mountain, Snake River Plain, Payette, and Harney His Walla Walla Plateau, which included southeastern Washington and north-central Oregon, was said to have a rolling surface with young incised valleys This region varies so greatly in its relief features that the term plateau has been found inept and inapplicable, separation into several sections has been found desirable The other sections are retained, although some changes in their boundaries have been made and a new section, the Owyhee, is recognized

nearly absent, and apparently the lava emerged from enormous cracks in the earth's surface. That many years may have elapsed between successive lava flows is proved by the eroded tops of some of the flows, the presence of soil later baked to bricklike material, and large quantities of charred and petrified wood. In the Snake River Canyon nearly fifty lava flows are exposed that aggregate more than a mile in thickness, and it seems reasonable that the lava will average nearly a mile thick over most parts of the Columbia Plateau. Towards the edge of the lava-covered region the flows thin out as they encroach on the slopes of the surrounding hills and mountains. The drainage was naturally interfered with by the lava flows, and many temporary lakes, some of considerable size, were formed in which silts collected, usually containing an abundance of fossil leaves. Later these lake beds might be buried under other lava flows. Streams like the Spokane and the Columbia rivers probably once flowed in quite different courses across the region and were pushed by the lava flows north and westward from their former locations to the foot of the mountains there, where they have eroded new valleys, almost at the contact between the lava and the exposures of much older rock. The surface over which the lava flowed was originally highly irregular, and considerable mountains were wholly or partly buried by the flows in Oregon and neighboring parts of Idaho and Washington. In some places the higher hills, called "steptoes" after the classic example of Steptoe Butte in eastern Washington, rise above the plateau surface and are entirely surrounded by lava, but they were never covered by it. Following and perhaps accompanying the outpouring of thousands of cubic miles of basalt, the surface of the Columbia Plateau was warped and disturbed by upfolds, downfolds, and faults. Much of the present relief of the region results directly from these earth movements. In a minor way erosion and deposition of sediments have modified the original surface features.

Stretching westward from the Rocky Mountains of central Idaho a series of mountain ridges and tilted plateaus extend to within thirty miles of the Cascades. The lava-covered country north of these central highlands and west to the Cascade Mountains, being all drained by the Columbia River and its tributaries, may be designated (1) the Columbia Basins subprovince. Other subprovinces of the Columbia Plateau might be (2) the Central Highlands or Blue-Wallowa-Seven Devils Mountains, (3) the southern marginal basins of the Snake River and central Oregon, and (4) the Owyhee Plateaus.

In east-central Washington detritus-covered plains occur at the lowest elevations, and from this central area (locally called the Columbia Basin) the lava country rises in all directions, forming marginal up-

lands that surround the saucerlike depression. The name (1) Central Plains is given to this low, flat section The marginal uplands differ in structure and relief and for this reason are separated into five sections. From northwest to southeast are the (2) Waterville Plateau, (3) Channeled Scablands, and (4) Palouse Hills To the southeast are (5) the Tri-State Slopes and to the west and south the (6) Yakima Marginal

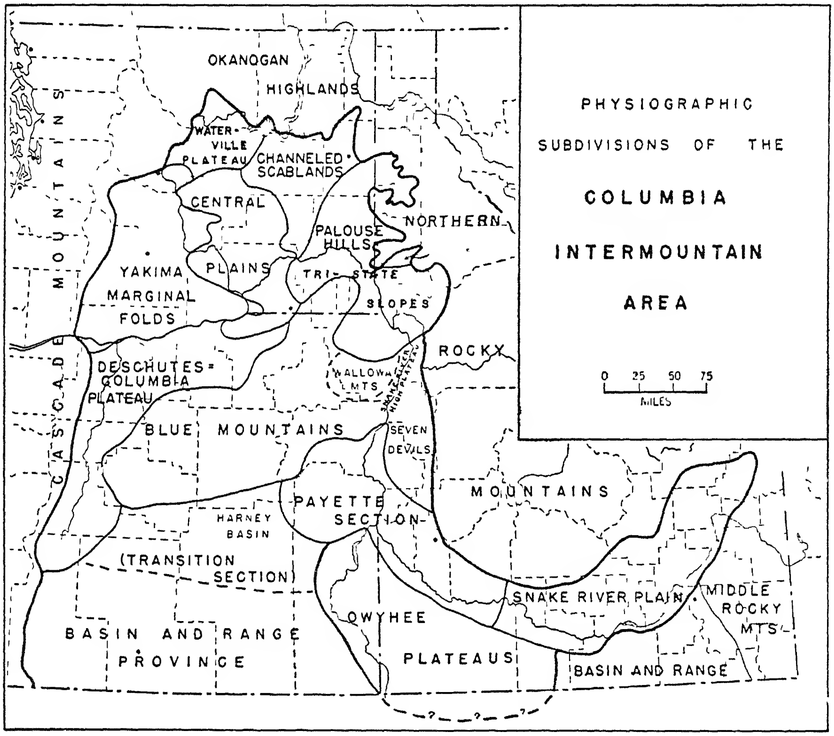


FIG 14 Physiographic divisions of Columbia Basins and Plateaus.

Folds. (7) The Deschutes-Columbia Plateau is used to designate the rolling and sloping plateau section in north-central Oregon

The lava country of southern Idaho has an elongated basin structure and is divided into an eastern section, the Snake River Plain, and a western, the Payette, which extends into eastern Oregon South of the Payette the lava has been uplifted to form the high Owyhee Plateaus In central Oregon the Harney Basin and high plains south of the Blue Mountains and west to the Deschutes drainage are considered a transitional section between the Columbia Plateau and the Basin and Range Province.

COLUMBIA BASINS

Waterville Plateau

The lava flows of the northwestern corner of the Columbia Plateau overlap the mountain slopes of older rock to the north and west and extend up the Okanogan Valley to Omak. The southern and southeastern sides of the plateau are determined by monoclinal folds where the relief descends a thousand feet from the plateau to the Quincy and Hartline basins. Across the moderately rolling surface of the Waterville Plateau extend deep canyons of the Grand Coulee and the Columbia River, the latter also forming part of the western border of the plateau. Moses Coulee does not completely cross the plateau. South

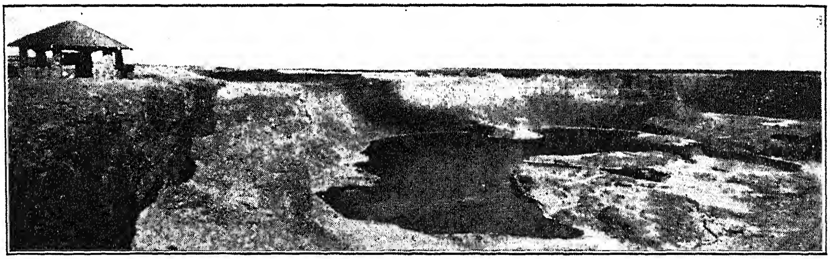


FIG. 15. Dry Falls in the Grand Coulee. In the glacial period this was a waterfall 4 miles wide and over 400 feet high. (*Photograph by DeLong.*)

of Waterville an upfold, the Badger Mountains, rising above the otherwise gently rolling surface of the region, is included in the folded marginal section to the southwest. The northern part of the Waterville Plateau was covered by ice of the Okanogan Lobe of the Cordilleran Ice Sheet, which deposited a prominent moraine extending in a horseshoe shape for thirty miles south of the Columbia River across the surface of the plateau from its western margin to the Grand Coulee. Huge erratic boulders, mostly of basalt, called locally "haystack" rocks, are a feature of the glacial deposits. Grand Coulee and Moses Coulee were formed chiefly from erosion by meltwater from the Ice Sheet.

Palouse Hills

The Palouse Hills occupy the eastern edge of the plateau between the Spokane and Snake rivers west to the unique, curious scabland tracts that extend from Spokane, southwesterly, to the confluence of the Palouse and Snake rivers. Palouse Hills are underlain by basalt flows. They are not, however, composed of residual material from these

rocks, but instead are built of loess blown from the dry basins to the southwest mixed with volcanic ash, and heaped into hills, elongated from the southwest to northeast and steepest in the latter direction. Wind, nivation, and reshaping by running water have united to form the hilly, mature topography of the Palouse. Four tongues of the Palouse region extend across the Washington border into Idaho be-

FIG. 16. Palouse Hills from the west. Note greater steepness and snow banks on the northeast slopes.

tween Coeur d'Alene and Lewiston. Hills of old crystalline rock, like Steptoe Butte, which were the highest projections of the old surface and were surrounded by lava but not covered by the basaltic flows, project above the general level of the country and increase in numbers towards the mountains of Idaho.

Channeled Scablands

The term, Channeled Scablands, was invented by J Harlen Bretz[2] to describe a region of unique topography that had been incised into the surface of the western part of the Palouse Hills and certain other

[2] J Harlen Bretz, "The Channeled Scablands of Eastern Washington," *Geographical Review*, Vol. 18, pp. 446-477, 1928.

sections adjoining the central plains in eastern Washington. In reality this area is a zone of "islandlike" hills covered with Palouse soil or other loessial soils that rise above the interlacing channels of bare lava rock, called "scabrock" by the early pioneers. The term, Channeled Scablands, is directly applicable only to those parts from which the soil has been removed, so that strictly speaking the area should be described as Palouse Hills mixed with Scablands.

FIG. 17. Scabland tract near Cheney, showing isolated hill of Palouse soil and topography surrounded by "Scabrock" from which the soil was removed by glacial meltwater. (*Soil Conservation Service.*)

To understand the development of the peculiar topography called Channeled Scablands, which is literally a youthful topography incised into the face of the mature topography that ordinarily covers the Columbia Plateau of eastern Washington, it is necessary to discuss briefly glaciation in this region. The Scablands were formed in the Glacial Period, when the northern edge of the region was invaded by ice from Canada which blocked the Columbia River west of Coulee Dam and covered the entire Spokane Valley. The melting of the ice furnished quantities of water which were unable to flow down the Columbia Valley because of the glacial ice dams, and this glacial meltwater accomplished important changes. Marginal lakes accumulated along

the ice front and the water rose until it overflowed the divide south of the Spokane and Columbia rivers and then swiftly cascaded down the sloping plateau toward the Columbia and Snake rivers Since the plateau from Cheney to Pasco drops nearly 2,000 feet in about 130 miles, the glacial melt water streams were swift and had great erosive power. These temporary large rivers washed away the surface soil from nearly two thousand square miles of land, and where the current was swiftest and most water concentrated the streams deeply incised themselves into bedrock.

Before the Glacial Period the country was covered with loess soil and had a hilly topography. The floods of meltwater eroded an amazing system of interlacing channels into the solid lava bedrock amid the remnants of the old mature relief, thereby producing a topography that resembles, on a huge scale, sheet flood erosion on an ordinary hill slope As mentioned, the bare eroded rock was called by the early settlers "scabrock," and the abandoned glacial spillways are spoken of as scabland channels or, collectively, as the Scablands. In many of these scabland channels, deep, rock-bound lakes occur in places where the floors were most deeply excavated by the torrents of swift water. Potholes, steep cliffs, ponds and swampy meadows, rocky buttes, water-eroded pinnacles and turrets of black basalt, flat-topped mesas, dry falls, abandoned cascades, and dusty or rock-bound former water courses, now deserted, characterize the scabrock channels. Debris from the scabland channels deposited at the canyon mouths or other favorable locations formed extensive gravel bars and other deposits, some of which extend into the central plains of Washington.

Central Plains

This section is often called the Columbia Basin in Washington, and its relief consists of gentle slopes and flat detritus-covered plains. The Saddle Mountains and Frenchman Hills extend from west of the Columbia River well into the "Big Bend" region of that stream, almost cutting the Columbia Basin into two parts, the Quincy Basin north of these regions and the Pasco Basin to the south. In southeastern Washington the drainage flows in all directions towards the central plains and leaves the area through the Wallula Gateway where the Columbia River breaks through the end of the Horse Heaven uplift that extends east from the Cascades. Lake beds and fluvial glacial deposits of gravel, sand, and silt cover much of the surface of the Columbia Plains. Being surrounded by higher land, these plains have a climate that is desert or semidesert. Deposits of the finer sand, clay, and silt helped form

the level plains of the Quincy region that will be irrigated from the Grand Coulee Dam. South and southeast of Moses Lake quantities of sand were brought in by the floods of glacial meltwater; and later the wind scooped out large "blowouts" and heaped the sand into dunes, forming a local desert area called "The Potholes," wholly unpopulated. Lake beds fill much of the Walla Walla Valley and near-by plains from Wallula east to Walla Walla and north to Eureka, and

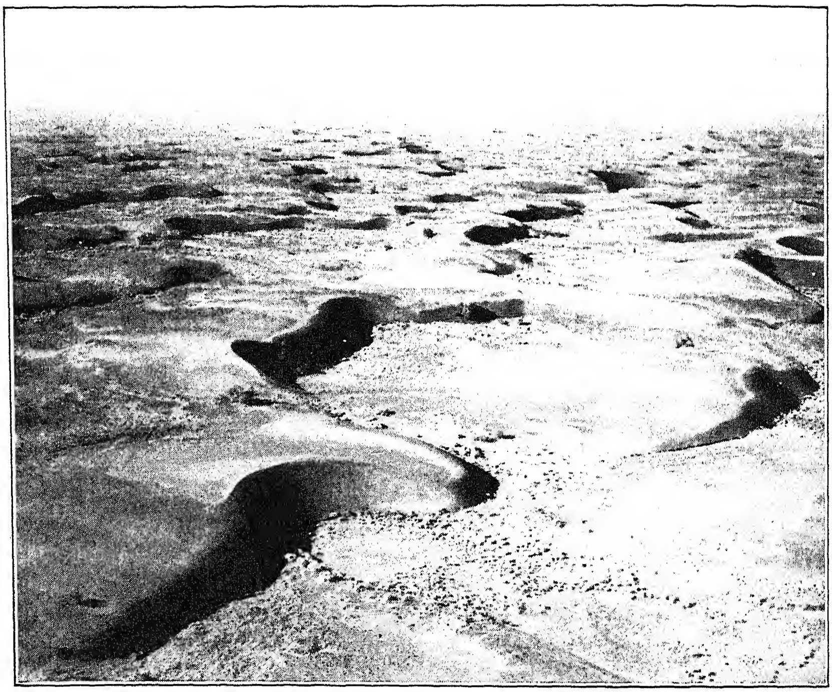


FIG. 18. The "Potholes" in the Columbia Basin southwest of Moses Lake. The view is taken from the south and shows peculiar shape of sanddunes developed on a rocky floor. (*Photograph by 41st Div. Aviation, Washington National Guard.*)

gravels and silts extend northwest up the Columbia River to the Saddle Mountain anticline. These lake beds and fluvial deposits generally form nearly level terraces and long gentle slopes somewhat dissected by erosion, and they present a marked contrast to the surrounding upland areas. The section extends between the Horse Heaven Hills and Blue Mountains into northern Oregon to include the so-called Umatilla Basin, a detritus-covered plain.

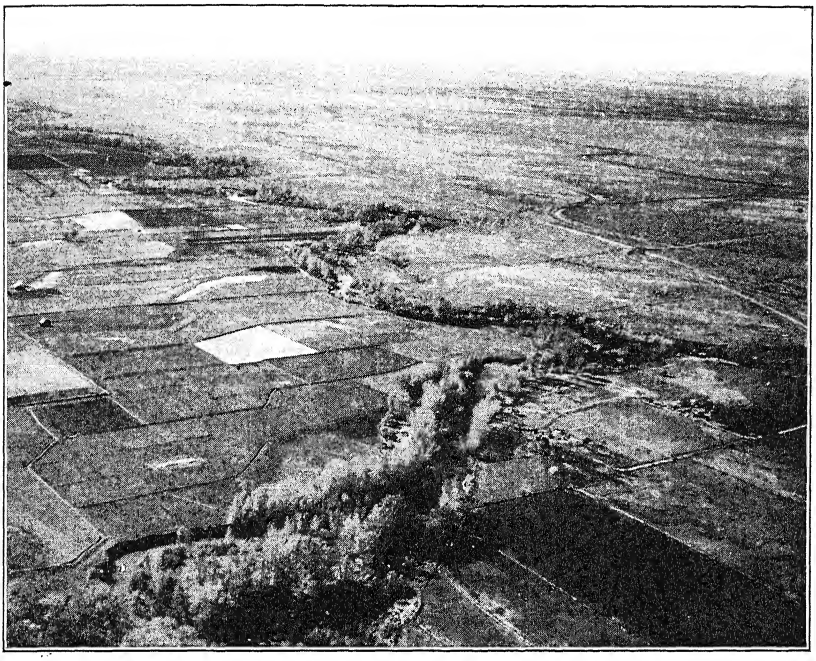


FIG. 19. Columbia Plains near Umatilla. (*Soil Conservation Service.*)

Yakima Marginal Folds

The term Yakima Marginal Folds is applied to a series of upfolded hills and ridges alternating with synclinal valleys that extend eastward from the southern half of the Cascade Mountains in Washington, between the Columbia River on the south and the Wenatchee Valley on the north. The Horse Heaven, the longest of the uplifts, lies in the extreme south of Washington. The Horse Heaven extends east beyond the Columbia River which cuts across near the end of the fold in the Wallula Gateway, a mighty water gap nearly 2,000 feet deep. Along most of their length, both the north and south slopes of the Horse Heaven are steep fault scarps. The fertile, irrigated Yakima Valley begins at Benton City and extends upstream, northward beyond the city of Yakima. The Yakima Valley is nearly severed into an upper and lower valley by a ridge that is crossed by the Yakima River at Union Gap, south of Yakima City. Several associated tributary valleys extend east and west on both sides of the main valley. Beginning a few miles north of Yakima the Yakima River has cut a series of stupendous entrenched meanders through several upfolds of basaltic lava. North of these ridges is the Kittitas Valley, which is bounded on the

east by the Saddle Mountains and on the north by the old rocks of the Wenatchee Range The uplifted lava flows of part of the Wenatchee Range as far west as Table Mountain are included with the Yakima Folds, together with the lower end of the Wenatchee Valley and the Badger Mountains of Douglas County The section projects into the Columbia Basin east beyond the river in two folds, the Saddle Mountains and the Frenchman Hills The ridges of the Yakima Folds trend in a generally easterly direction from the Cascade Mountains. The western boundary is obscure, since both lava flows and erosion slopes may extend from high in the Cascades well out into the eastern sloping plateaulike summits of the marginal folds. The section in the southwest is assumed to extend to the canyon of the White Salmon River. In general, the western border is determined by the fact that the Cascades show a greater degree of erosion, with sharper incisions into bedrock, and have a greater declivity of slopes than the Yakima Folds, but in many places the drawing of an exact line is difficult. A small folded area extends across the Columbia River into Oregon near Hood River.

Tri-State Slopes

North of the Blue-Wallowa-Seven Devils Mountains near the junction of the boundaries of Oregon, Washington, and Idaho and extending to the Rocky Mountains, the lava country consists of tilted upland and sloping plateau surfaces This section is called the marginal slopes or, better, the Tri-State Slopes It includes the uplifted block between the Clearwater and Salmon Rivers in Idaho, called Craig Mountain and Camas Prairie. In Washington the canyons of Tucannon, Asotin, and other creeks incise the sloping surface In Oregon the Grande Ronde and Imnaha rivers have carved deep and very precipitous canyons that separate the tilted plateaus into isolated strips whose surfaces slope generally to the north It seems probable that the tilted blocks result from warpings associated with the uplift of the Blue Mountains and Wallowas, but the slopes are generally separated from the mountains by faults or other structural break.

The Tri-State Slopes are in a youthful stage of topographic relief, and deep canyons have been eroded into the thick lava flows, sometimes completely sectioning them and cutting into exposures of sediments or old crystalline rocks below. The main streams in general flow in the direction of the slopes, and the hills are largely the interfluves between the valleys and are elongated in the same direction. In places extensive areas of the slopes have been little affected by erosion.

The vegetation is partly trees and partly grass, in the latter case similar to the Palouse.

Much of the soil is chiefly volcanic ash, which has made a rather thin but very youthful fertile soil, contrasting with the Palouse soil in that there is no differentiation into A and B horizons. Canyons eroded in the sloping lava flows have steep sides; and the top flow of

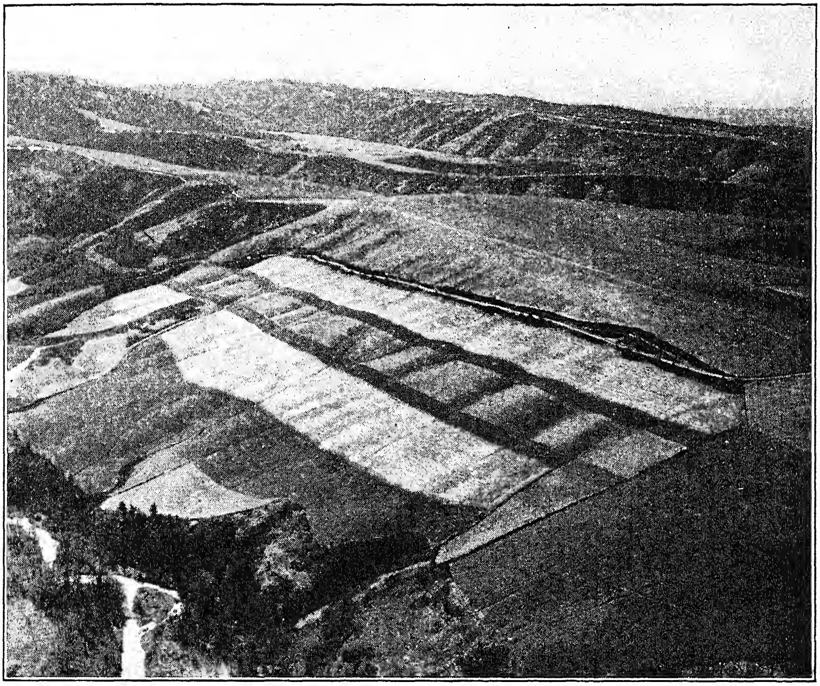


FIG. 20. Tri-state slopes north of the Blue Mountains in Washington. Note contour cultivation of land, only partly successful in preventing erosion. (*Soil Conservation Service.*)

the region usually is the rimrock of the canyon, indicating that so short a geologic period of time has elapsed since erosion began that little recession of escarpments determined by the hard portions of lava flows has yet had time to occur.

East of the last uplifts of the Blue Mountains the Tri-State Slopes begin to the north of the Grande Ronde and Wallowa valleys. There the sloping lava flows do not extend clear to the Wallowa Mountains but instead their south edge forms an escarpment facing the valleys. The sloping plateau in this vicinity has been most profoundly incised by canyons two to three thousand feet deep worn by the Grande

Ronde, Imnaha and Snake rivers, and their tributaries Between the canyons travel on the surface of the sloping lava flows is relatively easy, but to ascend or descend the slopes of the canyons is an appalling task either by automobile, on horseback, or afoot These canyons constitute a great handicap to travel, and improved highways are rare in this canyon section. The original surface of the tilted plateau eroded by the Grande Ronde River stood at 4,000 or 5,000 feet elevation in northeastern Oregon, descending to around 2,000 feet towards the Snake River near Asotin

The Craig Mountain section of Idaho lies between the Clearwater and Salmon rivers and attains elevations of more than 4,000 feet The higher portions of both the Grande Ronde slopes and the Craig Mountain area are covered with open forests mostly of yellow pine The timber ceases to grow toward the outer and lower parts of this tilted country. Canyons have isolated the original sloping surface into elongated strips and because of the steep canyon sides travel between them is very difficult. The chief sloping plateaus or high tilted mesas that have resulted are the Craig Mountain, including Camas Prairie in Idaho, the high flats about Anatone, and the much-dissected table land between the Grande Ronde and Imnaha and Snake rivers entrenched near the center by Joseph Creek and other streams.

Deschutes-Columbia Plateau

This section consists of that part of the Columbia Plateau from the Cascade Mountains nearly to Pendleton at the foot of the Blue Mountains. The western part is drained by the Deschutes River, and along this stream the surface rises regularly from the Columbia River to beyond Bend in central Oregon The eastern part begins at the high bluffs facing the Columbia, and slopes gradually upwards to meet the Blue Mountains South of Bend is a region of very recent volcanic activity, with rough black lava flows, scores of cinder cones, lava tubes, etc. To the east this area grades into the desert basins of central Oregon. Much of the surface between the canyon of the Deschutes River and the Cascade Mountains is covered with stones and gravel washed down from that range, especially during the Glacial Period. The canyons of the Deschutes and its main tributary from the east, the Crooked River, are deep and narrow throughout much of their length. Good soil covers the surface of the plateau on the north, from Hood River and The Dalles eastward Here the rainfall is adequate and good farming country has developed which produces large amounts of wheat, but toward the south, around Bend, Redmond, and Prineville, the rainfall drops off and irrigation becomes necessary

Here the irrigated land consists mainly of the river flood plains and pockets of fertile soil that have developed between the lava flows.

CENTRAL HIGHLANDS

Blue-Wallowa-Seven Devils Mountains

In central and northeastern Oregon, and extending into Idaho and a short distance into Washington, are the Blue Mountains, Wallowa Mountains, Snake River High Plateau, and Seven Devils Mountains, the last wholly in Idaho Essentially these uplifts form one mountainous section or subprovince.

The intermountain lava-covered region is nearly divided into northern and southern parts by a series of elevated lava plateaus and faulted or folded mountains. The general term Blue Mountains is applied to these uplifted and dissected plateaus and ranges that extend for 200 miles, from southeastern Washington first southward and then westward nearly to Prineville in central Oregon, within forty miles of the Cascades Intermontane basins and broad valleys are characteristic of the Blue Mountains, both within and along the margins of the uplifted blocks. On the east the Grande Ronde Valley and the Baker Valley separate the Blue Mountains from the Wallowa Mountains in northeastern Oregon. Essentially the Blue Mountains are horsts whose fault scarps are steepest on the south and east The northern part of the Blue Mountains consists mainly of warped and sometimes tilted plateaus, all highly dissected. The southern flanks of the mountains are more rugged and affected by stronger folding and faulting than the northern portion. Elkhorn Ridge, west of Baker, and the Strawberry and Aldrich Ranges further west are examples The western extension of the Blue Mountains, ending near Prineville, is called the Ochoco Mountains. In places lava has been uplifted in the Blue Mountains to elevations of more than 9,000 feet. In general the higher peaks are composed of ancient crystalline rocks, they may represent hills that were surrounded by lava flows but never covered by them In other cases erosion has completely removed the lava, and exposed the underlying granodiorite and other crystalline rocks in the heart of the mountains. Considerable mining, mainly for gold, has been done in these areas of old granodiorite and the associated placers deposited downstream. Marine sediments, lake beds, and other terrestrial deposits, mixed in part with volcanic ash and lava flows, outcrop in the region drained by the John Day River and its forks on the northwest slopes of the Blue Mountains and are also well developed in the Ochoco Mountain uplift The sediments are

attacked more effectively by erosion than the lava, and the resulting relief features are characteristically affected.

The Wallowa Mountains contain the highest peaks in northeastern Oregon. They consist of a mountain mass about thirty miles across with a center of old crystalline rock away from which dip the lava flows that originally were deposited approximately horizontally around the range. In the Glacial Period the Wallowas were strongly eroded by ice;

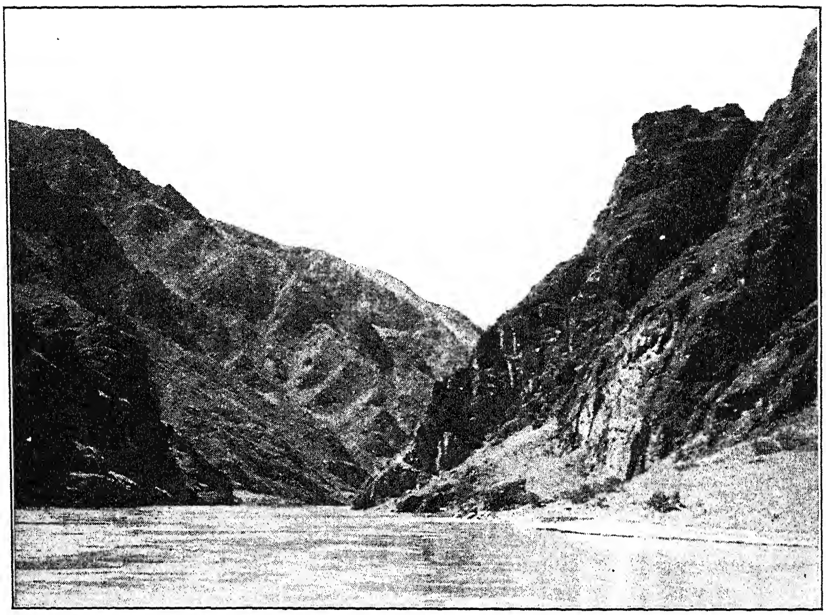


FIG. 21. The Snake River Canyon, the deepest in North America.

small remnant glaciers still exist, and the mountains contain the most alpine scenery of northeastern Oregon.

Across the Snake River in Idaho, west of the Salmon and Little Salmon Rivers, are mountains of a character similar to that of the Wallowas. While it is not certain, it seems probable that this rugged region, called the Seven Devils Mountains, had peaks that always have projected above the surface of the surrounding lava. Between the Seven Devils and the Wallowas the entire region was once buried by thousands of feet of lava. Then both the basalt and the two mountain areas were uplifted, the movement being accompanied by some faulting which helped to affect the relief and drainage. This high upwarped plateau attained elevations of 8,000 feet or more, and has been severed by the great Snake River Canyon which for one stretch

of nearly 30 miles averages nearly 6,000 feet in depth The connecting plateau between the Wallowas and Seven Devils Mountains might well be called the Snake River High Plateau South from the Seven Devils Mountains stretches a disturbed, sloping, lava-covered plateau whose surface dips beneath that of the Snake River Plains north of Weiser. The northern border of the Wallowas uplift is the Wallowa Valley on its north side, and that of the Seven Devils is assumed to be the canyon of the Salmon River.

SOUTHERN MARGINAL BASINS

Payette Section

This name was applied by Fenneman to the western part of the Snake River downwarp which contained considerable recent sediments and is more dissected than the Snake River Plain to the east. However, the Owyhee uplands to the south are separated, in this paper, from the Payette Section to which they were attached by Fenneman The Idaho portion of the Payette Section was the site of extensive interior lakes between periods of volcanism, and, as the lake beds are easier to erode than the lava, the country is more dissected than the eastern part of the Snake River Plains. King Hill is about the dividing point between the Payette and the Snake River Plain The Payette extends westward into Oregon to include a dissected lava-covered region drained by the Malheur and lower Owyhee rivers. From a human standpoint the Payette Section has a deeper soil, lower elevation, and longer growing season than the Snake River Plain to the east, so that a larger variety of crops can be raised there than in the middle and upper Snake River Valley.

Snake River Plain

This name is applied to the crescent-shaped lava-covered country drained by the Snake River from Yellowstone Park southwest to the vicinity of King Hill in southern Idaho The Snake River Plain drops from an elevation of about 5,000 feet on the east to about 2,000 feet on the west in the Payette Section This drop of 3,000 feet in about 400 miles, or eight feet to the mile, has resulted in the development of the great canyon of the Snake River and of several waterfalls, of which Shoshone Falls, 200 feet, and Twin Falls, 120 feet, are the highest. The eastern half of the Snake River Plain is underlain by younger lava than the western portion. In fact, in the Craters of the Moon country, some of the most recent volcanic activity in the United States has occurred. The Snake River Plain slopes toward the south

as well as toward the west, and the river is asymmetric with the depression, flowing along the course of an arc across the plains toward the south side of the lowland. In a desert climate, this country requires irrigation for successful agriculture. The strip of country

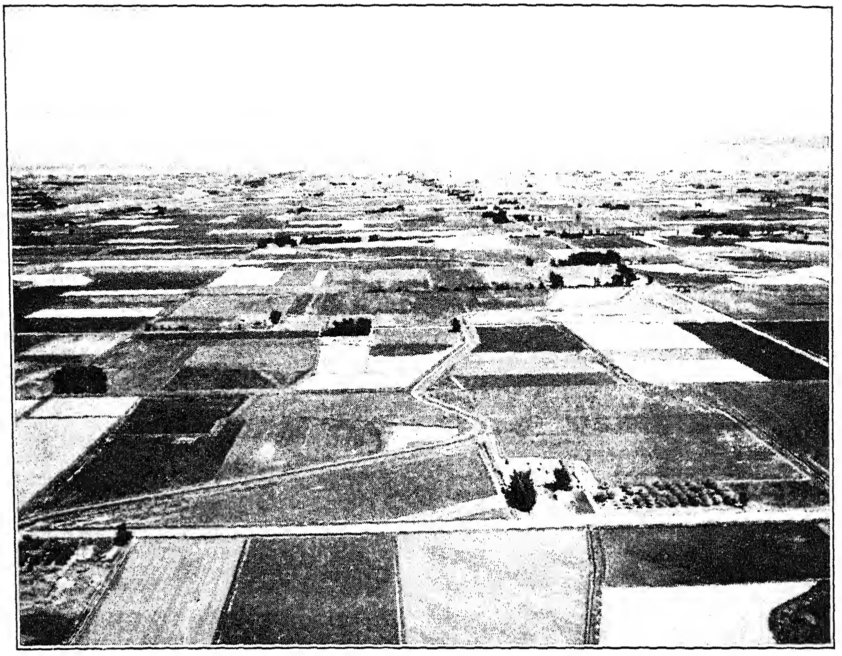


FIG. 22. Air view of the irrigated and intensively cultivated Snake River Valley in western Idaho. (*Soil Conservation Service.*)

ten or twelve miles wide on either side of the river that is devoted to farming is popularly called the Snake River Valley.

Transition to the Great Basin

South of the Blue Mountains, between the Deschutes Plateau and the Owyhee uplift, is a desert basin section that contains lava, volcanic ash, lake beds, and detrital deposits. The eastern part has been called the Harney Basin for many years, and the name could be applied to the entire area. The western half is called locally the Great Sandy Desert or High Plains. Covered largely with fine volcanic debris, it presents a uniform flat and desolate appearance without stream valleys or elevations. The Harney Basin drains toward Harney and Malheur Lake, the latter a playa that varies greatly in area, depending upon the rainfall and runoff. In the Harney Basin, surrounding

the central shallow lakes and playas, are alluvial plains and a small volcanic area of cinder cones and lava beds, further out are marginal plains somewhat dissected by erosion The Harney Basin and Great Sandy Desert have interior drainage A number of minor fault scarps break the surface, representing a sort of transition from the true basalt-covered "Columbia Plateau" to the Great Basin, or better the Basin and Range Province, to the south.

OWYHEE PLATEAUS

In southeastern Oregon and southwestern Idaho a series of high warped plateaus is drained by the Owyhee River, they are included together here to form a section called the Owyhee.[3] The part of the Owyhee uplift lying in Idaho is highest, it is called the Owyhee Mountains. Here erosion has exposed ancient, mineral-bearing crystalline rock which is surrounded by high cuestas of uneroded lava. Acid lavas predominate in the eastern part of the Owyhee Section, but they have been mainly covered by basalt in the western portion The Owyhee and its tributaries cut deep canyons in their course across the high desert uplifts of the Owyhee plateaus, which extend a short distance south of the forty-second parallel into Nevada.

HUMAN USE

The diversity of relief features, climate, and soils that exist in the Columbia Lava Basins and Plateaus has naturally resulted in diverse industries and irregularities in distribution of population.

Mining within the area for metals is restricted to localities where old crystalline rocks have been exposed at the surface by erosion of the overlying basaltic flows or where the outcrops of the old rocks towered so high that floods of lava never covered the exposures. Some gold placers have developed by erosion of gold-bearing quartz veins Some crushed stone, gravel, and sand are for construction. Diatomaceous earth is produced at several points, and a few opals of fair quality have been found deposited in holes of porous lava A little natural gas is produced in the Rattlesnake Hills near Benton City, Washington.

Timber is restricted to the higher plateaus and mountains and to the rainier part of the scablands in the northeastern section of the plateau near Spokane. The forests are utilized extensively in Oregon. The wooded mountains are also used for summer grazing, for fishing and hunting, and for resort purposes.

[3] The suggestion for doing this was made by Alfred L. Anderson, Cornell University, in an unpublished manuscript.

Soil has developed only on the old flows The pumice and new rough lava have almost no soil and but little vegetation, they are useless for farming and of little value for grazing The timber is likely to be juniper of small value. Large areas where recent volcanic activity occurred in Idaho and Oregon are government owned

Two types of agriculture are predominant on the Columbia Plateau: (1) cash grain farming and (2) intensive irrigation agriculture Dairying is important in some localities, and the drier and rough sections find use for stock raising

The principal producing areas for cash grain, mainly wheat, are the Palouse Hills, the Tri-State Slopes, and the Deschutes-Columbia Plateau, with minor areas of production elsewhere The trading centers and farming population are rather evenly distributed over the wheat-growing sections since the productivity of the land and its occupancy by man are fairly uniform

The chief sections developed by irrigation are the flat desert plains and dry valleys that are favored by an adequate supply of water and a relatively long growing season Major areas occur in the Yakima, Kittitas, and Wenatchee valleys within the zone of the Yakima Folds in Washington and the Snake River Valley in Idaho Minor areas are the Umatilla district around Walla Walla, Milton-Freewater, Kennewick, and the Spokane Valley. In the future over one million acres of the flat lands in the Columbia Basin will be irrigated by the Grand Coulee Project Considerable good soil occurs near Quincy to be irrigated Orchard fruits, especially pears and apples, root crops, like potatoes, and sugar beets, alfalfa, and small fruits and vegetables are the leading crops of the irrigated districts, although some wheat is raised, especially in southern Idaho.

Dairying is important in many of the irrigated sections and also on the fairly well-watered northern portion of the scablands near Spokane The drier parts of the scablands are the site of stock ranches for both sheep and cattle. The Harney Basin, southern half of the Deschutes Plateau in Oregon, and the drier parts of the Snake River Plains in Idaho support a scanty population of sheepmen and cattlemen where irrigation water is not available in quantities to attract intensive settlement and the rainfall is too small for dry farming. The Owyhee region is almost wholly devoted to stock raising The dry parts of the province afford a striking contrast between the densely populated irrigated sections, with their numerous trading centers and intensively cultivated small farms, and the adjoining dry farming and stock raising country where the population may be less than one person per square mile.

THE BASIN AND RANGE PROVINCE

The Basin and Range Province extends into south Idaho and southern Oregon The line dividing it from the Columbia Plateau or Snake River Plains to the north is rarely definite, the areas grading gradually into each other For convenience as the boundary betweeen the Basin and Range Province and the Snake River Plains and Owyhee sections, the water parting is generally used East of the Cascade Mountains the surface of southern Oregon has been disturbed by a series of faults extending generally in a north-south direction. The fault blocks have been uplifted to form asymmetric mountains with one face much steeper than the other Southwestern Oregon is dominantly a rim-rock country Lavas are characteristic of the higher elevations while flat lake basins occupy the lower places The steep faces of the fault blocks have been only partly dissected by erosion showing the comparative recency of the earth movements The depressed blocks between the uplifts are usually filled with debris washed from the adjoining mountains, and, since they occur in a dry region, mostly have interior drainage Towards the center of the basin shallow lakes occur, most of which are temporary playas Goose Lake, Warner Lake, Summer Lake, and Abert Lake are among the larger and better known During the rainier periods of the Pleistocene these lakes were all much larger and deeper

Among the fault-block mountains are Winter Ridge west of Summer Lake, Hart Mountain east of Warner Lake, Abert Rim east of Abert Lake, and, highest of all, Steens Mountain The chief exception to the dominance of interior drainage is the Klamath Lake region which drains outward to the Pacific, but the area has similar uplifted fault blocks and depressed basins and is therefore included with the Basin and Range Province. South and southeast of Klamath Falls, beginning in Oregon and extending to Lassen Peak in California, is a recent volcanic area called the Modoc Lava Beds that contains cinder cones and lava tubes amid the rough, bleak, basaltic flows The Klamath Lakes lie westernmost in the Province and receive drainage from the Cascades which helps to make them fine bodies of water. As mentioned elsewhere, the Harney Basin, containing Harney and Malheur lakes, is a transitional area from the Basin and Range Province to the plateaus and mountains to the north

The Basin and Range Province in Oregon has an elevation of 3,000 to 5,000 feet, with mountains rising to still greater heights Steens Mountain attains an elevation between 9,000 and 10,000 feet, high enough for small glaciers to form during the Glacial Period The lower

country is treeless and the ground is covered only with scattered sagebrush and clumps of bunchgrass, but scattered juniper appears at the 4,000-foot elevation and open groves of ponderosa pine begin at about 5,000 feet. Cycles of dry years follow periods of somewhat greater rainfall, and the level of the lakes responds to the differences in precipitation, sometimes causing large but shallow lakes to dry up completely.[4]

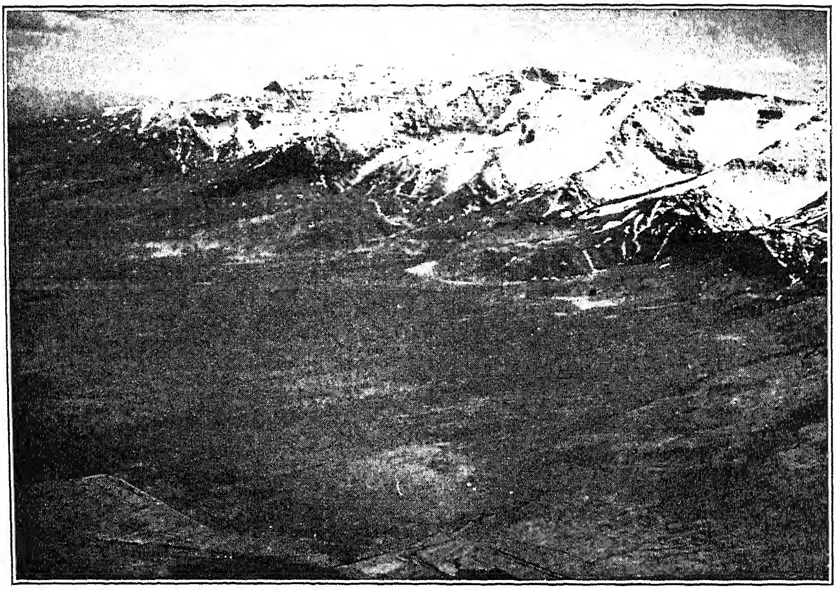


FIG. 23. Aerial view from northeast of the high fault scarp of Steens Mountain. An example of "Basin Range" structure in southeastern Oregon. (*Photograph by Richard E. Fuller.*)

In the extreme south-central part of Idaho, between the Rocky Mountains and the Owyhee Plateau, are several fault-block mountains and associated basins which form a part of the Basin and Range Province. Some of the ranges, as the Albion Range in Cassia County south of Burley and Albion, contain a nearly complete Paleozoic rock series and in addition pre-Cambrian sediments. The Albion Range is highest (10,451 feet) and once supported mountain glaciers. Minerals occur, but production is small. The Cassia City of Rocks south of

[4] For an excellent discussion of this subject, see "Rainfall and Tree Growth in the Great Basin," by Ernst Antevs, American Geographical Society, New York, 1938. For the Harney Basin, see "Geology and Ground Water Resources of the Harney Basin, Oregon," A. M. Piper, T. W. Robinson, and C. F. Park, Jr., Water Supply Paper 841, U.S.G.S., 1939.

Cache Peak contains huge boulders, domed monoliths, castle rocks and pedestals of grotesque forms and shapes, a curious erosion area worthy of being created into a "National Monument."

In general both the Oregon and Idaho areas included within the Province are used for grazing rather than agriculture. Irrigation is necessary for agriculture and in most of the country the water supply is inadequate for extensive projects. Furthermore, part of the land in Oregon lies at such a high elevation that summer frosts preclude the successful growing of most crops except hay. The population is scanty, and little development can be expected in the future. The largest herds of antelope left in the United States are found in southeastern Oregon, some of them are in the Hart Mountain Antelope Reserve which was established to help protect this rapidly diminishing species.

Southeastern Oregon has never been crossed by projected railroads because of its paucity of resources. Only branch lines touch the edge of this high desert area from the east at Burns; on the west, at Bend; on the south, at Lakeview and Winnemucca, Nevada This was a frontier region when crossed by minor trails of the Oregon pioneers. It still has frontier conditions, with few trading centers, schools, or churches Harney County in southeastern Oregon is larger than Massachusetts. It has a population of one-half person per square mile, and sometimes it is hard to find the persons.

Note Alfred L Anderson, in a paper entitled "Physiographic Subdivisions of the Columbia Plateau in Idaho," appearing in the *Journal of Geomorphology*, Volume 4, Number 3 October, 1941, has presented a classification for Idaho somewhat different from Freeman's in this chapter Anderson recognizes five subdivisions for Idaho: Snake River Plain, Palouse, Craig Mountain, Seven Devils, and Owyhee

SECTION 3

ROCKY MOUNTAIN PROVINCE

By J. D. Forrester

The geological development of the northern Rocky Mountains has given rise to a wide range of natural wonders which are hardly surpassed the world over. Magnificent mountain peaks, capped with everlasting snow, rear their heads above beautiful but lesser mountain lands set with cascading streams and crystal lakes. In this region are located the far-famed Yellowstone, Grand Teton, and Glacier National parks and the magnificent Hells Canyon of the Snake River, surpassing even the Grand Canyon of the Colorado in depth, great mines like the Sunshine, largest single silver-producing mine in the world, and the fabulous copper deposits of Butte, and the extensive forested uplands and cultivated valleys with their marked variety of plant and animal life.

These mountain lands where once the intrepid frontiersmen found most difficult barriers to their wanderings are today served by several transcontinental railroads and are marked by splendidly engineered highway systems. This is the country of John Mullan, Lewis and Clark, John Colter, Chief Joseph, John Bozeman, Father De Smet, and other notable figures of the early Northwest Here the emigrants to Oregon, Idaho, and Washington sought out the trails and waterways that led on through the mountains toward the Pacific Coast.

Location and Extent

The northern and middle Rocky Mountains are classed as entities largely through the fact that they are separated, from the southern Rockies and the Basin and Range Province of Utah, in their southern and eastern extent by wide, open plains or basin areas. For the purposes of this book, the region described will include the state of Idaho, the mountain counties of Montana, a strip of Wyoming west of 110 degrees longitude, and the extreme northeastern corner of Washington. Except for brief references the continuation of the mountains into Canada will be discussed in a separate section.

The region is about 500 miles long in a north-south direction and

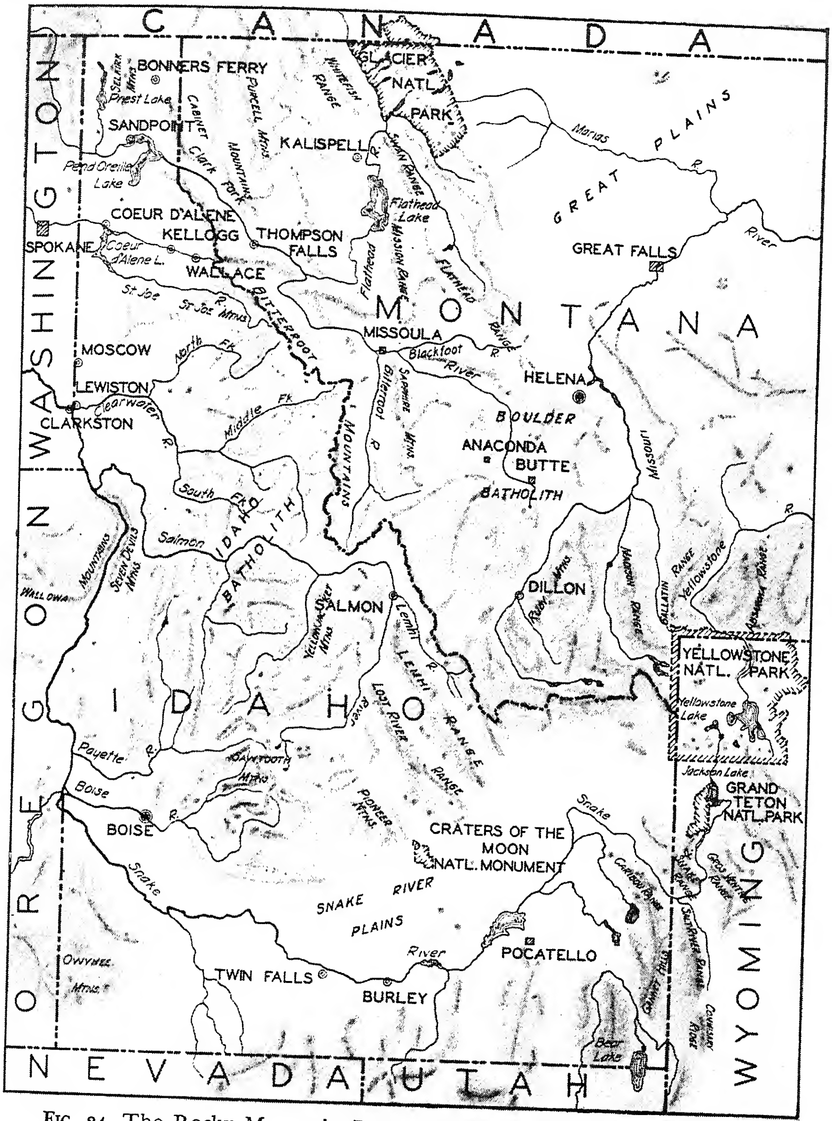


FIG. 24. The Rocky Mountain Province of Idaho and western Montana.

375 miles easterly and westerly Not only does this broad section of the United States include many massive mountain ranges and remarkably high peaks, but it also includes the bordering and intermontane[1] valleys Fenneman[2] points out that one of the distinguishing characteristics of the northern Rocky Mountains in respect to the other Rocky Mountain systems is that the northern mountains are not extensively linear nor do they exhibit marked structural control, whereas the middle and southern Rockies have linear trends and the main crests are flanked by outward-dipping strata. He notes that in the northern province the mountains ". . . are more like extensive plateaus, deeply and ruggedly carved by erosion."

However, the northern Rocky Mountains do possess remarkable linear structural features in the magnificent, elongated, north-south trending, trenches or troughlike depressions that have been developed from the Okanogan Valley of Washington across Idaho into Montana The famous Rocky Mountain Trench extends from northern British Columbia through Montana in the Flathead and Bitterroot valleys and probably extends down the Lemhi Valley of eastern Idaho Drainage of the Mackenzie, Fraser, Columbia, Clark Fork, and Snake rivers all occupy part of the Rocky Mountain Trench. Further westward are other trenches, the Kootenai, the Purcell, Pend d'Oreille, Colville, and Okanogan Most of the major cities and farming operations are located in these north-south trenches. Both rivers and the railroads, as they move westerly towards the sea coast, are impelled to follow roundabout routes, sometimes nearly reversing directions, in order to go from one trench to the next. In altitude the northern Rockies range from approximately 1,000 feet above sea level near Lewiston, Idaho, up to elevations of 12,000 feet or more towards the center of the higher mountain masses.

The northern Rocky Mountains constitute the backbone of the United States in that they form the Continental Divide and hence have the watersheds of both the Atlantic and Pacific drainage systems The southern, central, and northwestern portions of the province are drained by the westerly flowing Columbia and Snake rivers and their tributaries. In the northeastern section, except for a portion of Glacier Park that drains to Hudson Bay, the tributaries of the Mis-

[1] Intermontane is here used to connote a relatively small region essentially surrounded by higher land areas

[2] N M Fenneman, *Physiography of Western United States,* p 92, McGraw-Hill Book Company, 1931.

souri River gather the water that eventually finds its way into the Gulf of Mexico.

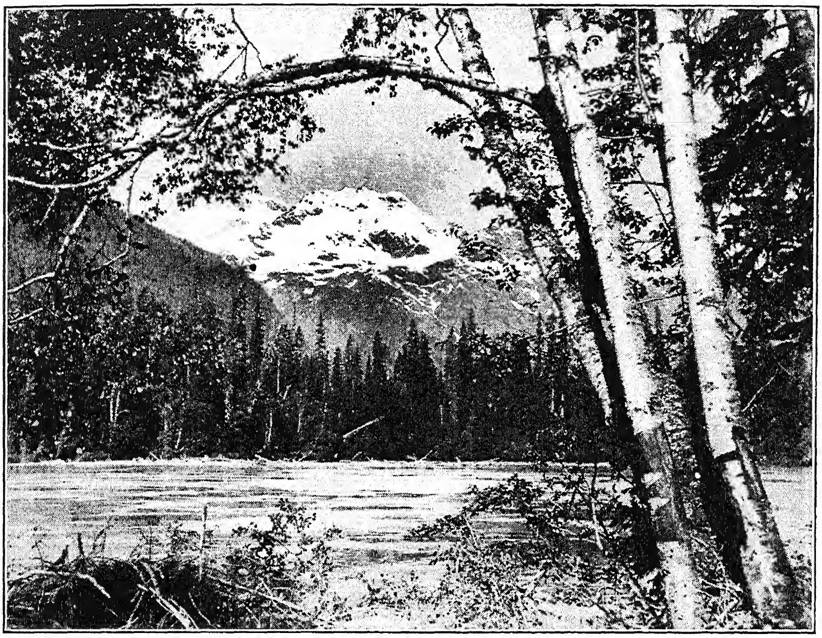


FIG. 25. Trident Peak and Columbia River, British Columbia.

GEOLOGIC HISTORY

Field studies reveal that the Rocky Mountains are relatively young[3] and that as such they have existed for only a short period of geologic time.

Throughout most of its known geologic history the region was one of low-lying lands, marked here and there perhaps by slightly higher land areas, but, when taken as a whole, characterized by its sunken nature. Tremendous thicknesses of shallow water sediments[4] were brought in from the sides of the trough and were deposited in the sea water that had flooded into this depressed area of the land mass. In other words, an exceedingly long period of quiet sedimentary deposi-

[3] The term young is used in the geologic sense. If the age of the earth is taken as 2,000,000,000 years, more or less, the first appearance of the Rockies may be said to have occurred approximately 60,000,000 years ago.

[4] It is known that the sediments cited in the text were deposited in shallow water because characteristic ripple-marks, rain drop imprints and mud cracks are often preserved even though the original loose materials are today hard, tight rocks.

tion existed in the Rocky Mountain region before there were any such mountains developed To be sure, there were minor fluctuations of this troughlike area during the time it was being filled, and such breaks in the orderly cycle of deposition account for the segregations of each era[5] of geologic time These breaks are reflected to a greater or lesser degree in the rocks of the region Sometimes the uplifts were so pronounced that the sediments of whole periods are missing from the normal sequence However, the picture in general was mainly one of quiet deposition for an immensely long time until finally more rapid and violent fluctuations began and a total breakup of the trough was initiated This collapse was the birth of the Rocky Mountains, as such, and resulted in a great warping and breaking of the previously deposited sediments. The collapse and attendant folding were most pronounced in the zone where the trough had been best developed and the greatest thickness of sediments had accordingly been deposited. The mountains, therefore, have probably been erected over the old depressed area and their axes generally are over the place where the deepest part of the sunken zone formerly was. The destruction of the trough apparently was brought about by thrusting[6] stresses working parallel to the earth's surface.

Volcanoes were active and much lava was thrown out upon the land as the sediments, which had been originally essentially horizontal, were smashed, crumpled, and, in some places, thrust up and over each other The sea, of course, was driven out of the region and back toward the coastal areas by the uplift The rocks, then out of water and exposed to the atmosphere, started to disintegrate and decompose The winds and rains began to cut the formations away and to develop hills and valleys upon their surfaces. The streams naturally sought out the less resistant rocks to flow upon and to wear away most readily, and major drainage systems were developed and extended It is reasonable to conclude that these early stream valleys and attendant divide areas were more linear in extent and approached more closely the appearance of the middle and southern Rockies than do those of the northern region today. Apparently the wearing away process of the uplifted lands continued until many of the exposed sedimentary rocks had been removed from the highlands.

However, the Rocky Mountains were to be affected by further movements, for, after this beveling off process had reached a notable development, the earth, within the mountain region, was again up-

[5] See Geologic Column for the Northwest, Table 2

[6] It appears that the stresses acted quite as those we can produce when we rumple up a sheaf of papers on a table by moving our hands across the table top

lifted, essentially vertically. Accompanying this vertical uplift were tremendous masses of hot molten materials which forced their way into the crust, but stopped their intrusion before they had broken through to the surface. These masses, such as the Idaho Batholith and the Boulder Batholith of Montana, upon cooling and solidification, formed the granites and associated rocks that are the core or "backbone" of our mountain systems. They are exposed in the moun-

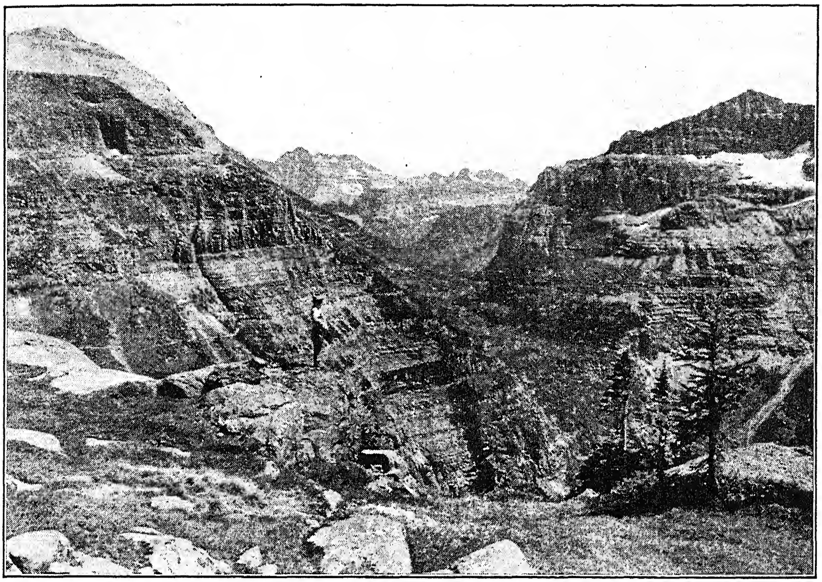


FIG. 26. East from Boulder Pass, Glacier National Park. The mountains are mainly carved from metamorphosed sediments, called argillite, by the action of stream and glacier erosion. (*Photograph by Hileman.*)

tainous regions today only because the former overlying or "blanketing" cover of sediments, under which they cooled, has now been removed by the activity of water, ice, and wind. In fact, the beveling off and removal of the rocks went on so extensively that the mountains were cut away to a near plain (peneplain) with much lower divide areas between river systems than exist today.

It is of importance that as the granites cooled they gave off mineral-bearing vapors and liquids that worked their way upwards through breaks and cracks into the cooler rocks and then themselves became cool enough to solidify. Such natural phenomena are now the "ore" veins that are present in certain parts of the mountain areas. In addition, it appears that this second uplift, with its accompanying intru-

sive materials, was more widespread than the first uplift of the Rockies. Some areas seem to have been forced up higher than others within the mountain region, indeed, some lands around the border zone of the folding uplift (as in Montana, east of Glacier National Park), and heretofore not affected, were pushed up in wartlike form by intrusions of granite material Such mountain masses, because they developed only with the second Rocky Mountain disturbance, have rocks within them that were essentially undistorted when the Rocky Mountains were first formed.

It seems that the drainage pattern developed on the surface by the streams was in rather close approximation to what it is now, for, as the new plain land surface was formed and the granite core was progressively more widely exposed by erosion, a loss of guidance by the varying sedimentary strata undoubtedly occurred [7] This had the effect of freeing the streams from control by the weaker rocks wherever the resistant granite became exposed by erosion This condition pertained particularly to the central Idaho and southern Montana mountain masses of the region, with their pronounced granite intrusions Beyond the limits of the intrusions the beveled edges of the sediments still were exposed and so were able to exert their function of stream guidance.

Such master streams as the Snake and Salmon rivers and their chief tributaries, which flow with little regard to older structures, were probably established and flowed much in the same direction as today.

Uplift of the general region again occurred, in fact, some authors suggest several periods of re-uplift. Just as in the previous case, however, the "pushing up" seems to have been more marked and pronounced in certain areas than in others, and this resulted in differential warping, breaking, and tilting of the older erosion surfaces. The near level surfaces, called relict peneplains, can still be identified to good advantage, particularly in the higher mountain areas of central Idaho, where a concordance of summit levels is oftentimes very impressive.

[7] Sedimentary rocks, because they are layered and sorted materials in the beginning, generally show varying resistances to erosion Some formations are weaker to erosion than others and thus tend to be cut away and form valleys more rapidly than adjoining strata This fact does not hold true so widely in unbroken granites and so there is little, if any, tendency to control and guide the stream channels Since there are larger expanses of granite (20,000 square miles more or less) exposed in the northern Rocky Mountain province of Idaho and Montana than there are generally in the middle and southern Rocky Mountains, it seems likely that this is the reason why a linear control of mountain crests and stream valleys is not so pronounced in the central portion of the northern Rockies

Some of the master streams were large enough to maintain their courses and to cut down as rapidly as the land was raised, whereas many smaller streams were not able to keep pace with the uplift and so became ineffective as new rivers were formed. As in the case of the Salmon River, some of the master rivers "entrenched" themselves directly across the mountain mass whereas others flowed in the differentially downwarped or trenchlike regions that have been previously mentioned and which were so magnificently developed in northern and eastern Idaho and western Montana. The old central erosion surface was dissected and carved up, and a very rugged and rough topography has thereby resulted.

Still later, volcanoes again became active in certain parts of the province, particularly in the southern and eastern areas. Volcanic fragmental material and great quantities of lava flowed out upon the land surface, filling and obliterating many of the valleys in their path, and lapping up onto the flanks of the higher mountain sectors. The great lava plains of southern Idaho were thus developed, and, somewhat later, Yellowstone National Park had its birth as a wonderland of nature.

Alpine glaciers formed in the summit regions of the mountains and stupendous ice sheets pushed their way down from the north over part of the northern Rocky Mountain province These magnificent ice masses, upon melting, have left unmistakable evidence of their former magnitude through the valleys they have carved and the drainages they have affected. Today only a few remnants of these glaciers remain in the higher mountain sections. They are mere skeletons of their former grandeur, but in man's eyes they are still magnificent creations

Even during the periods of volcanic activity and glaciation, some earth movements and readjustments were still taking place in the Rocky Mountains. All the complicated geologic history has united to give the complex result visible today Every development has left its mark and has had a function in the end There is little wonder that this province has such a multitude of outstanding natural features when we consider the involved history it has experienced.

SPECIFIC REGIONS

The northern Rocky Mountains have contrasting relief features; some sections lack continuity of definite ranges, whereas, in others, there is a marked development of linear alignment and orientation of valley and highland systems. Local names have been given to certain eminences and they have been so designated (Fig. 24). In many instances, the names have been determined by human interest

and associations, and so bear little significance to the geologic and geographic history of the region as a whole.

Southern Idaho

Perhaps the most impressive features of southern Idaho from the geological standpoint are the great lava beds of the Snake River Plain. They are bounded on the south by mountains of the basin and range type which come up from central Utah and on the north and east by the massive mountain lands of central Idaho and western Wyoming. These great volcanic accumulations, which are an integral part of the greater Columbia lava field and are in some cases 4,000 feet or more in thickness, are the locale of the intriguing Craters of the Moon National Monument and other interesting phenomena.

Central Idaho

On the north, the lava rocks of the Snake River Plains lap up onto the great, baldy exposed, granitic mountains, indeed, in east-central Idaho, they run far up into previous low-lying valleys toward the Yellowstone National Park plateau, another center of volcanic activity. The mountains which cover the major portion of central Idaho are themselves very rough although the continuity of old peneplain erosion surfaces still is evident.

The magnificent Salmon River, that had established its westerly course prior to the later uplifts of the mountain region, has now entrenched itself directly across the batholithic mass and this, together with the formation of tributary streams, has engendered the development of some of the most difficult and rugged terrain in the United States. The Salmon is the far-famed "River of No Return" through this portion of its course.

In the western section of central Idaho, therefore, nonoriented valleys have thus been formed, largely through the erosive dissection of the older erosion surfaces developed on a granite surface. However, to the eastward, extending into western Montana, the valley areas and contiguous uplands are linear in a general north-south direction and have probably resulted through differential uplifts of certain sections. Sun Valley, a famous mountain-land recreation center of western America, is situated near the southern edge of this highland region of central Idaho.

Western Wyoming

In western Wyoming and the contiguous extreme eastern Idaho, magnificent mountain peaks called the Grand Tetons, now a national

park, rear their heads into the sky Rugged, more or less north-south trending ranges, made up of contorted, broken, and highly thrusted strata,[8] extend northward to the volcanic, plateaulike basin area of Yellowstone National Park. Possibly the reason for the extreme folding and uplift of the Teton region is that this was the site of one of the deepest accumulations of sediments in the ancestral, pre-Rocky Mountain trough. The complicated physiographic development has resulted in beautiful lakes, fertile, intermontane valley lands, and rugged, glaciated mountain peaks.

Southern Montana

Montana is romantically known as the "Land of the Shining Mountains," and here is found a marvelous diversity of mountain forms and scenery Separated on the south from the middle Rocky Mountains of western Wyoming by the Snake River Plains and the Yellowstone Basin, and bounded on the east by the Great Plains, are large distorted masses of sedimentary strata and wide expanses of granitic rocks Basin or valley areas are often circular and pockety in development, and, except for certain master streams, there are remarkably few extensive, lengthwise valley or river tracts A good example of a basin is the region around Butte, Montana, that is enclosed on three sides by the sinuous line of the Continental Divide Since the various uplifts were not all the same, and erosion and dissection have been also greater in some areas than in others, it follows that the region differs in the ruggedness of its relief. For instance, the Montana region does not exhibit a comparable ruggedness to the Salmon River country of central Idaho. Strangely, however, the central Idaho mass is generally covered by a soil overburden to a far greater degree than are the hills and valleys of the less dissected sections.

Northern Idaho and Northwestern Montana

The bedrock of northern Idaho and northwestern Montana is dominantly of sedimentary origin Although the granite rocks have broken through to be exposed in some few isolated areas, and, without doubt, underlie the sediments over the entire region, the surface forms in this section are those characteristically developed in stratified materials.

[8] In this region are some of the grandest faults of North America These are breaks in the rocks accomplished by the great thrusting and vertical stresses as the sedimentary materials were crushed and crumpled Many of the faults have resulted in over-riding of younger sediments by older ones as they have been thrust up and over in trying to get relief from the deforming forces

The original sediments seem to have been more resistant to warping and folding by thrusting stresses than in other areas of the province. Their tendency was to break and rupture and to override one another during application of the smashing force. The great Lewis Overthrust along the east front of Glacier Park and other extensive, north-south trending faults were formed as major structural features of the region.

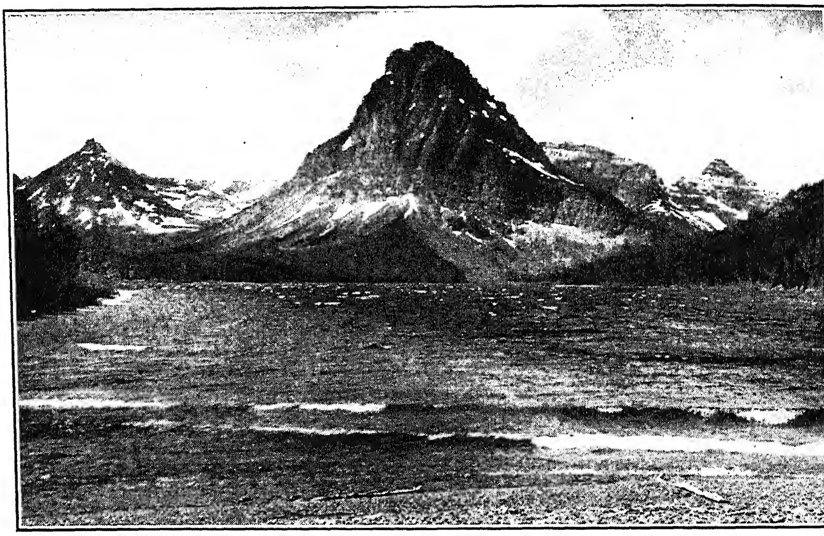


FIG. 27. Upper Two Medicine Lake, Glacier National Park. (*Courtesy Great Northern Railway.*)

Some notable warping of the rocks also developed, but in the Glacier National Park area, for example, the very old rocks are remarkably flat for the extreme disturbing experiences they have undergone. As the region suffered later differential uplifts, the effects were to further develop fault zones and fracture systems, and trenchlike valley forms frequently resulted. These structural features noted above generally carry on into southern Canada as the Canadian Rockies, an integral part of the Rocky Mountain system. Because of the stratified nature of the rocks and lineal fault trends, it happens that a marked north-south parallelism and orientation of streams and divide areas have developed widely in this section of the Northwest Province. The famous Purcell and Rocky Mountain trenches are outstanding examples of such phenomena.

Great glaciers, both as ice sheets from the north and as mountain types from the high divide area, came down and extensively changed pre-existing land forms by the profound works of rock erosion and

sediment deposition. Mountain masses were scoured and cut, valleys were choked with debris, and old drainage systems were readjusted. The jagged peaks, wide U-shaped valleys, and countless lakes, large and small, serve as acute evidence of this glacial activity. Of such lakes, four at least deserve special mention. They are the beautiful Coeur d'Alene, Pend Oreille, and Priest lakes of far northern Idaho, and Flathead Lake in Montana. This province is the land of which Glacier National Park is a part, and here several remnants of former massive ice masses may still be observed.

Okanogan Highlands

The term Okanogan Highlands is applied to the Rocky Mountains in northeastern Washington, north of the Spokane-Columbia rivers and between the Cascades and the Pend Oreille Valley near the Idaho line. Like the rest of the Rockies the region is an old peneplain that was uplifted to form a plateau, after which it was considerably dissected by streams and glaciers. The summit levels of the Okanogans have an altitude of 4,000 or 5,000 feet, above which rise rounded summits to elevations as great as 7,000 or 8,000 feet. These higher summits represent the monadnocks on the old peneplain and include such mountains as Calispel Peak, Moses Peak, Mt. Spokane, and Old Dominion Mountain. The bedrock consists of some lava and large areas of granite, much metamorphic rock, and important exposures of sediments including slates and limestone. Mineral deposits, especially of lead, zinc, silver and gold, are widely distributed. Limestone is quarried for cement rock at Metaline, and important deposits of clay are utilized at Clayton. The world's largest known deposit of magnesite occurs in the mountains a few miles west of Chewelah, where a calcining plant is located.

A notable feature of the Okanogan Highlands are the prominent north-south running trench valleys that probably represent elongated downfaulted or downfolded blocks between the highlands that were uplifted. If we start on the west to enumerate, the larger depressions are. (1) Okanogan, (2) San Poil-Upper Kettle Valley, (3) Columbia-Lower Kettle River Valley, (4) Colville Valley with its extension north to the Columbia through Echo Valley, and (5) the Pend Oreille Valley. East of the Pend Oreille Valley rises a southward extension of the Selkirk Range of Canada. All the important towns and most of the farms and ranches are located in the trenches. Here are the areas of best soil. Land is more level and the growing season is longest so that conditions for farming are far more favorable than on the uplands, where the growing season is short and the areas of good land are small.

Towns are generally situated in a main valley where side valleys converge, thereby favoring the development of extensive trading areas. Omak, Okanogan, and Tonasket in the Okanogan Valley, Chewelah and Colville in the Colville Valley, and Newport and Ione in the Pend Oreille Valley are examples

HUMAN USE

During the formation of the mountains, certain intermontane basins and other valleys became the site of lakes in which sediments accumulated At other times glacial and stream debris would cover the valley floors. The present rivers are now usually busy reworking these lake beds, outwash, and fluvial deposits, with the result that extensive terraces have developed. These level benches are easy to irrigate and cultivate, and probably more inhabitants of the Rocky Mountain Province are supported by farming than by any other occupation Most of the population of the Rockies lives in the valleys, some mining settlements being the principal exception Stockmen may send their herds to graze during the summer in high mountain meadows, but the home ranches are in protected valleys Campers, hunters, fishermen, and even the lumbermen are only temporary residents of the truly mountainous parts of the Rockies. Industries are as yet but little developed except for those that depend on natural resources of minerals, timber, and agriculture.

In addition to the present and potential tangible wealth, such as metallic and nonmetallic mineral deposits, timber resources, agricultural opportunities, water power, and wildlife occurrences, the people who inhabit the region possess a heritage of the so-called intangible assets of recreation, health, and well-being that result from the environment, giving them a firm foundation for the building of our civilization.

Yellowstone National Park

Yellowstone National Park, the oldest and probably best known of our national parks, is located, for the most part, in northwestern Wyoming, although the extreme western and northern portions overlap into Idaho and Montana respectively

Geologically, Yellowstone Park is unique, for not only is it unrivaled the world over for the size, number, and complexity of its 3,000 geysers and hot springs, but it also contains many other spectacular natural phenomena.

Practically the entire region is volcanic. The great interior plateau, which is considerably higher than the lava plains of the Snake River

area, and the immediately adjacent mountains are composed of ash and lava that were thrown out from within the earth. A multitude of different volcanic rock forms and types are present and may be seen to particularly good advantage at Obsidian Cliff, on Mount Washburn, and in the Grand Canyon of the Yellowstone River. The canyon, incidentally, is so outstanding that even without the geysers and other features it would, within itself, justify the existence of a national park. Yellowstone Lake, beautiful streams and waterfalls, extensive petrified forests, and the evidences of past glacial activity, all contribute to the awe-inspiring character of this western wonderland.

Glacier National Park

Glacier National Park is located in northwestern Montana adjacent to the Canadian border, and on the north adjoins the Waterton Lakes

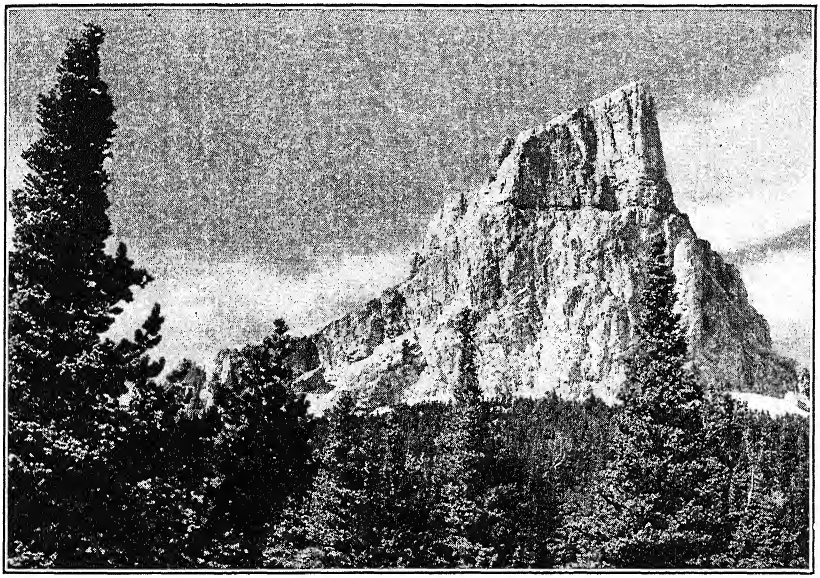


FIG. 28. Chief Mountain, Glacier National Park, a peak resulting from erosion along the Lewis Overthrust.

Park of Canada. Although each park is administered by its respective government, they are both components of the greater Waterton-Glacier International Peace Park established in 1932 by presidential proclamation.

As might be expected from its name, Glacier National Park exhibits outstanding features of glacial activity. Living glaciers are quite acces-

sible, and the results of ice activity of the past are everywhere apparent. Rugged, sharp divide areas, great cirques, U-shaped valleys, glacial debris deposits, and numerous magnificent lakes are widely present. In addition to these interesting glacial phenomena, the park reveals many other intriguing points of geologic and geographic importance. Immense thicknesses of very old, pre-Cambrian rocks (Belt Series) are present, and some of the most profound faults, commonly called "overthrusts," have left evidence of their development. The great Lewis Overthrust resulted in the old rocks being pushed up and slid easterly over younger rocks for a distance of approximately twenty-five miles. An exceptional example of this development is revealed by Chief Mountain near the eastern limits of the park. The upper portion of the mountain is composed of ancient limestone which rests on relatively very much later shale. Because of this movement of harder, more resistant rocks over softer materials, the mountains along their eastern side commonly terminate in massive, precipitous walls. Foothills are conspicuous by their absence along the Glacier National Park-Great Plains line of contact. That is to say, the plains abut sharply against the mountain front with no minor rises so common along most mountain ranges.

Grand Teton National Park

Grand Teton National Park of western Wyoming contains perhaps the most alpine-appearing scenery in this country. The rocks of the Teton Mountains have been crumpled and broken and the whole range tilted in blocklike fashion to the westward. Subsequent erosion by water and ice has, of course, profoundly affected the mountain mass, but the contrast of the west and east sides of the range is impressive. From the Idaho side, the westerly inclined, broad, top of the block is notable whereas the view from the Jackson Hole Basin is one of precipitous cliffs developed by faulting and erosion.

Pleistocene glaciers have carved and cut the uplifted rocks and have played a major role in developing the magnificent scenery of the Teton area, which is beautifully reflected in the lakes along their eastern front. Prior to the extensive glaciation, Jackson Hole had been formed by the erosion of the headwaters of the Snake River.

Although living glaciers still exist in this area and may be studied at first hand, the remarkable depositional and erosional effects of ancient ice activity are widely apparent. Sharp, jagged mountain crests and polished and grooved rock walls contribute to the massive, precipitous character of the Grand Teton's topography.

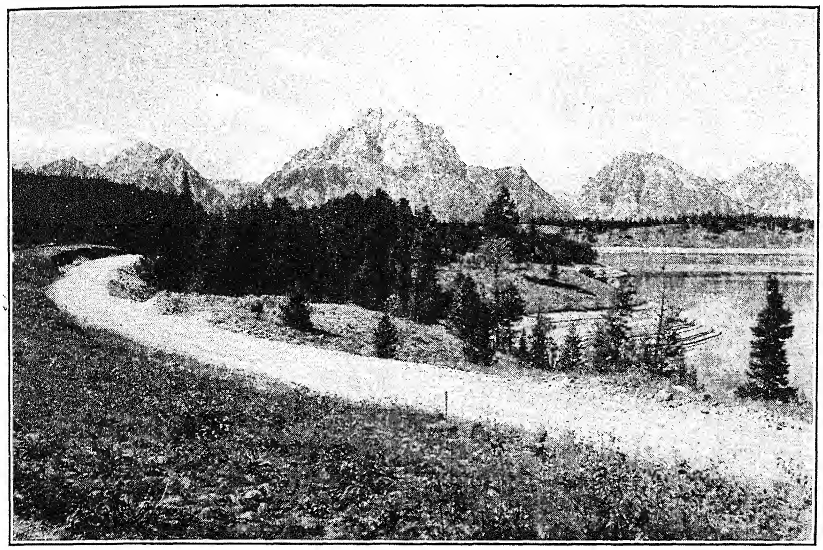


FIG. 29. Grand Teton mountains from the Jackson Hole, Wyoming. (*U.S. Department of Interior.*)

Craters of the Moon National Monument

Craters of the Moon National Monument encompass about thirty-nine square miles of the lava field of south-central Idaho. This section of desolate lava waste, unmarked by streams, is, indeed, an unusual phenomenon. Big Cinder Butte is one of the largest purely

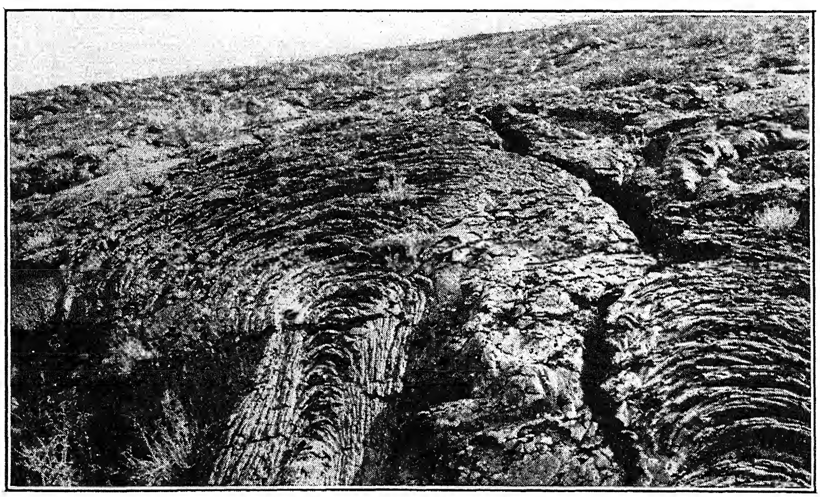


FIG. 30. Lava structure in the Craters of the Moon. (*U.S. Department of Interior.*)

basaltic[9] cinder cones in the world The mention of the presence of basalt should not be construed to be an unusual phenomenon for this is the material that comprises the Snake River Plains as a whole

Three periods of lava extrusion or volcanic activity have been identified in the Craters of the Moon area. The first was marked by the issuance of thick, rough, blocky flows that were fed from a rift or fissure in the earth's crust. Cinder cones were also formed during this eruption A second extrusion developed still further cinder cones and obliterated or covered much of the earlier forms that had, by this time, cooled and weathered somewhat. The third eruption followed very closely after the second period of activity. The black basalts were thus poured out to cover still further pre-existing flows and cones.

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- Department of Geology and Mineral Industries, 702 Woodlark Building, Portland, Oregon
- Department of Conservation and Development, Olympia, Washington
- U S Bureau of Mines, Washington, D C
- U. S Geological Survey, Washington, D C

The following magazines frequently publish articles on Northwest geology and physiography *Geographical Review, Journal of Geography, Northwest Science,* Cheney, Washington, *Pan-American Geologist, Journal of Geology.*

[9] Basaltic igneous rock is a form type which is rich in iron and relatively low in silica It is commonly dark in color

SECTION 4

RELIEF FEATURES OF SOUTHERN BRITISH COLUMBIA

By N. F. G Davis

Southern British Columbia has a diverse topography, characterized by high mountains, deep valleys, and gently undulating range country Rugged mountains rise on either side of a high central plateau, which narrows toward the International Boundary East of the plateau are the Columbia and Rocky systems, separated by the Rocky Mountain Trench. On the west are the Coast Mountains and the partly submerged Vancouver Island Mountains

The Cascades extend into southern British Columbia for about 100 miles, where they comprise the deeply dissected Skagit, Hozomeen, and other ranges which lie between the lower part of the Fraser River valley and the Interior Plateau. The Coast Mountains of British Columbia are orographically the continuation of the Cascades northward from the lower Fraser Valley. This deep valley, one of a number which cut right across the Coast Mountains, is a convenient line of division, for although the ranges north of the Fraser River valley have a structure and history similar to the northern Cascades, they differ in that they are bounded on the west by the Pacific Ocean The Puget Sound lowland between the Cascades and the Olympics in Washington becomes the Inside Passage between the Coast Ranges and the Insular Mountains of British Columbia. The Coast Mountains are deeply dissected and glaciated. Three types of surface are found erosional remnants of an old arched upland--few towards the center of the ranges; glaciated horns, combs, and ridges—more numerous towards the center of the ranges, and glacially rounded domes—mainly near the western edge. In southern British Columbia elevations rarely exceed 9,000 feet, but Mount Waddington, the highest peak, rises to 13,260 feet.

Pacific Coast Range of Canada

The west slopes of the Coast Range descend steeply into the Pacific The coast line has a drowned appearance, and is deeply indented by arms of the sea in a reticulating (netlike) pattern of northwest- and

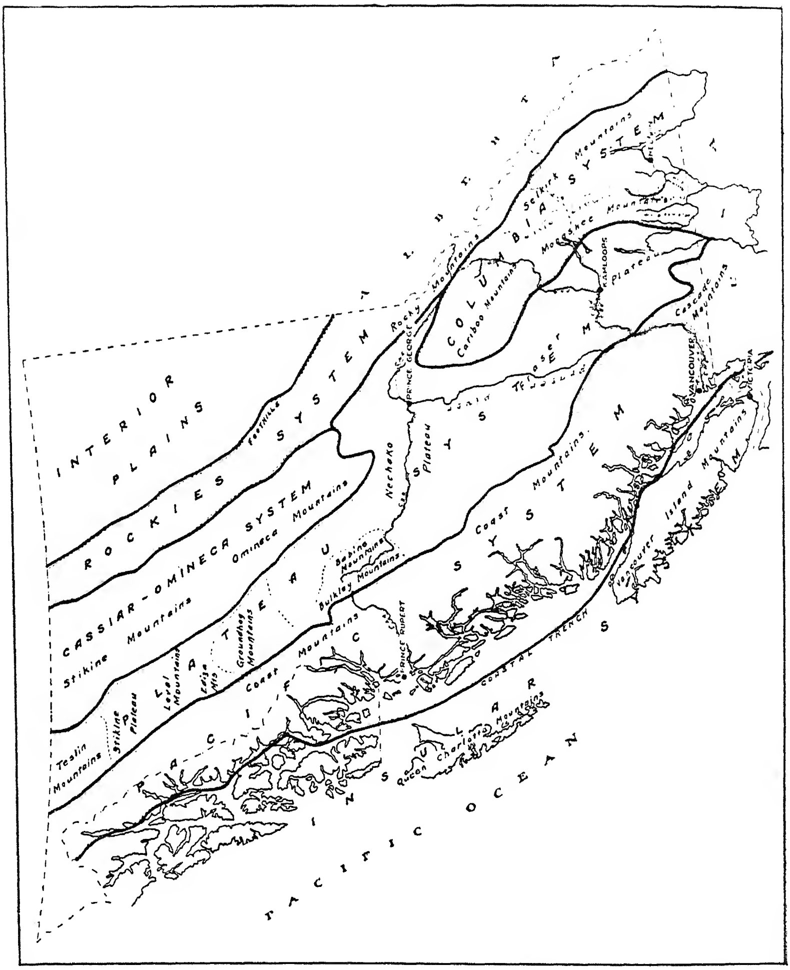

Fig. 31. Physiographic Divisions of British Columbia.

northeast-trending stretches of fiord which meet at abrupt angles The beauty of this fiord coast rivals that of Norway Thick stands of almost impenetrable timber cover the slopes to over 4,000 feet elevation Excessive rainfall on the west side and great ice-field reservoirs inland feed rivers capable of great hydroelectric power development.

Valleys are deep and U-shaped in transverse profile. In longitudinal profile the valleys are steep at their heads, and gentle or even reversed over the rest of their lengths. Some have been overdeepened by glacial action near their mouths, and have floors as much as 1,000 feet below sea level A few valleys, such as the Fraser, are antecedent to the present slopes, and penetrate the ranges

The mountains of the Vancouver and Queen Charlotte Islands have a topography like that of the Coast Mountains, but they are not as high Elevations of 4,000 to 5,000 feet are usual, and only a few mountains exceed 6,000 feet. These mountains are really a northward extension of the Coast Range of Oregon and Washington. Narrow coastal plains lie on the east and southeast sides of Vancouver Island. Here there is agricultural development, especially around Courtney, Duncan, and on the Saanich peninsula north of Victoria.

The flood plain of the Fraser River from Hope, 90 miles inland, to its mouth, makes an area of about 900 square miles of rich, flat land Systems of dykes and drainage canals are an important factor in the development. Lulu and Sea islands, parts of the Fraser River delta itself, are also rich lands, and have been made available in part by dyking, draining, and pumping to prevent incursion of sea water.

Interior Plateau

East of the Cascades and the Coast Ranges lies the Interior Plateau region of British Columbia. For the most part the transition from the coastal mountains to the plateau is abrupt; but in places there is a zone 10 to 15 miles wide of gradually falling ridges. In the southern part, where it is called the Fraser Plateau, the elevation is 4,000 to 5,000 feet. The surface is flat or gently undulating, higher near the bordering mountains and sloping inward. Isolated mountain masses, either erosional remnants or volcanic accumulations, rise 2,000 to 3,000 feet above the plateau. Much of the flat surface is made by volcanic flows. This surface is cut by trenchlike valleys (for example, the Fraser, Thompson, and Okanagan) to depths of 2,000 to 3,000 feet Normal alluvial terraces occur in these valleys, but many terraces are remnants of glacial deposition—both on a large scale in lakes formed by ice damming, and on a small scale by tributary deposition when large glaciers filled the main valleys. Many of the deep valleys

are still occupied by lakes—for example, Kamloops and Okanagan lakes. Flat lands suitable for agriculture or grazing are found on the valley floors, on the terraces, and on the upland between the valleys The southern part of the plateau region has large tracts covered by sagebrush and bunchgrass, but irrigation can be practiced in some of the valleys For the most part transportation routes follow the valleys, and thus travelers get the impression that the region is one of considerable relief At the International Boundary, mountain ranges narrow this plateau to the width of the Okanagan Valley.

Columbia System

Between the Interior Plateau of British Columbia and the Rocky Mountains lies a rugged mass of mountainous country, called the Columbia System. Deep longitudinal valleys divide this system into three mountain groups. The Cariboo Mountains on the northwest are separated from the Monashee Mountains to the east by the deep valley of the North Thompson River and its tributary, Albreda River The Monashee Mountains are separated from the Selkirk Mountains to the east by the south-flowing part of the Columbia River, which along its course forms the Arrow Lakes All three groups are bounded on the northeast by the Rocky Mountain Trench These mountain groups are older than the Rockies, and, although their ranges do not show as distinct a parallelism as the Rockies, they present a formidable barrier to penetration, and their crests are fretted and serrated by glacial action. Some of the peaks reach elevations of over 11,000 feet, and extensive areas over 8,000 feet have alpine characteristics. Most of the surface, however, consists of heavily wooded slopes between 2,000 and 7,000 feet in elevation, mantled in many places by thick deposits of drift In general, the ranges maintain a northwest trend, and present steep slopes both eastward and westward. The forest cover almost duplicates the thick growth of the Coast Ranges, and helps to make these mountains more inaccessible than the Rockies. The deep longitudinal valleys show the results of both glacial erosion and deposition, and many are occupied by long, narrow lakes such as the Kootenay and the Slocan. At the International Boundary the Monashee Mountains can be divided into a number of units—the Midway, Christina, and Rossland ranges—which are members of the Okanogan highlands to the south in Washington. The Selkirk Mountains extend into Washington, Idaho, and Montana. Flat land suitable for agriculture is scarce in this region, and is confined to deltas and lake shores, terraces and flood plains of the large valleys.

The Canadian Rockies

The Rocky Mountain Trench is one of the most outstanding and persistent relief features of British Columbia It extends in a northwesterly direction from the International Boundary for over 1,000 miles, and varies from 2 or 3 miles to as much as 10 miles in width. The bottom of this great valley has a maximum elevation of 2,700 feet, and is occupied by the headwaters of the Kootenay River, flowing south, the Columbia River, flowing north, and the Fraser River, flowing north. All these rivers finally reach the Pacific Ocean The Trench has a complicated structural history, which in many parts is obscured by heavy glacial deposition. In some places, particularly from Windermere and Columbia lakes south, the flat valley floor and wide bench lands along the sides serve as agricultural and range country.

The Rocky Mountains are a series of parallel, northwest-trending ranges with elevations of 7,000 to 13,000 feet Mt Robson, the highest peak, has an elevation of 12,972 feet. Rising gradually from trough-like valleys in the west and falling off abruptly in the east, the ranges resemble gigantic breakers Glaciation has serrated the crests, and the ice, which has remained on the higher peaks, culminates in the Columbia ice field between the Canadian Pacific and Canadian National Railways The largest area of partly ice-covered alpine scenery in North America is found in the Canadian Rockies (See frontispiece)

Transverse valleys, inherited from a premountain building cycle of erosion, penetrate the ranges. Three such valleys serve as passes for the transcontinental railways the Yellow Head, between the Fraser and Athabasca rivers, at an elevation of 3,720 feet, the Kicking Horse, between the Kicking Horse and Bow rivers, at an elevation of 5,372 feet, and the Crowsnest, between the Old Man River and Kootenay drainage, at an elevation of 4,459 feet.

The main features of the southern part of the Canadian Rockies are due to crustal movements and normal stream erosion. Valley glaciers have greatly modified the details of the higher uplands, and most lakes are due to damming by glacial deposition. Longitudinal valleys are mainly subsequent, but Tertiary faulting and tilting have affected blocks, particularly near the International Boundary, which have consequent streams on their slopes The transverse valleys carried eastward-flowing rivers from the older mountain ranges of the Columbia System, but the faulting and formation of the Rocky Mountain Trench have allowed rivers, the Fraser, Columbia, and Kootenay, to capture by headward erosion the headwaters of these eastward-flowing streams. Some through-valleys now exist as wind gaps with no major flow of

drainage through them The west sides of the ranges carry thick forest; but the steep east slopes are not as thickly timbered, and grasslands extend into the mountain valleys on the east

The Geologic Story

The geological story of southern British Columbia resembles that of the United States south of the forty-ninth parallel in its sediments, intrusive and volcanic rock, and the periods of uplift and erosional history.

The Rocky Mountains of southern British Columbia are composed of great thicknesses of pre-Cambrian, Paleozoic, and Mesozoic sediments, which in most places follow one another without marked angular unconformities and are unaccompanied by plutonic (deep-seated igneous intrusions) or volcanic rocks The pre-Cambrian is 20,000-30,000 feet thick, the Paleozoic 10,000-30,000 feet, and the Mesozoic sediments and volcanic reach a maximum of 20,000 feet. The Columbia System, which includes the Selkirk, Monashee, and Cariboo Mountains, is composed mainly of late pre-Cambrian and Paleozoic beds which have been intruded by plutonic bodies The Interior Plateau has a few areas of pre-Cambrian rocks, but is built mainly of Paleozoic, Mesozoic, and Tertiary sediments and volcanics All but the post-Middle Tertiary beds are invaded by plutonic masses. In the late Jurassic the land west of the Rockies, including the Monashee and Selkirk Mountains, was uplifted, folded, faulted, and intruded by batholiths of granodiorite and other rocks. The Coast Mountains are a series of batholiths, ranging in age from Jurassic to Lower Cretaceous with a little of the sedimentary cover left to form roof pendants, mainly of late Paleozoic and Mesozoic formations. Vancouver Island consists largely of early Mesozoic sediments and volcanics intruded by plutonics of the same age as in the Coast Mountains. After the uplift and erosion, late Mesozoic sediments and volcanics were deposited unconformably on the earlier beds. All the formations in southern British Columbia, except the late Tertiary sediments and volcanics, have been folded and faulted by mountain-building movements.

The uplift of the Rocky Mountains came later than that of the Columbia Mountain system and the Coast Mountains. Like the similar occurrence south of the border, the compressive forces were great enough to develop thrust faults that moved ancient pre-Cambrian sediments for upwards of thirty miles over younger and weaker rocks of the Great Plains, which after erosion by rivers and glaciers have given the area a scenery similar to that of Glacier Park in Montana Other periods of land elevation followed at intervals both in the

Rockies and western British Columbia. Great volcanic flows covered parts of the Interior Plateau in the Miocene in the same way as on the Columbia Plateau in the States

Pleistocene glaciation affected the whole of southern British Columbia Glacial striae groove the ridges at elevations up to at least 6,500 feet Thus only ridges above that level protruded as nunataks above the ice The ice extended from the mountain regions on both sides of the Interior Plateau, and it could not have been more than 3,000 feet thick over the plateau. Instead of using the term "Cordilleran Ice Sheet" in referring to this glaciation, we should better describe it as the Cordilleran system of intermontane, piedmont, and valley glaciers. Glaciofluvial deposits were laid down in the valley bottoms, and drift mantles the slopes. On the coast near Vancouver at least 1,000 feet of Pleistocene deposits were laid down They consist of two glacial drift deposits separated by stratified sands and clays Interglacial beds are also found in the interior. Postglacial uplift of as much as 1,000 feet is shown by elevated beaches along the coast, by the deep erosion of the glaciofluvial deposits, leaving them as hanging terraces in the Interior Plateau valleys, and by the cutting of canyons by rivers circumventing glacial plugging of their valleys

In the Coast Mountains north of Vancouver and in a few places on the Interior Plateau, recent volcanics occur They overlie till and occupy postglacial canyons

CHAPTER 4

CLIMATES OF THE PACIFIC NORTHWEST[1]

By Phil E. Church

Climate is perhaps the most important environmental factor in the Pacific Northwest. Even casual observation indicates that the climatic

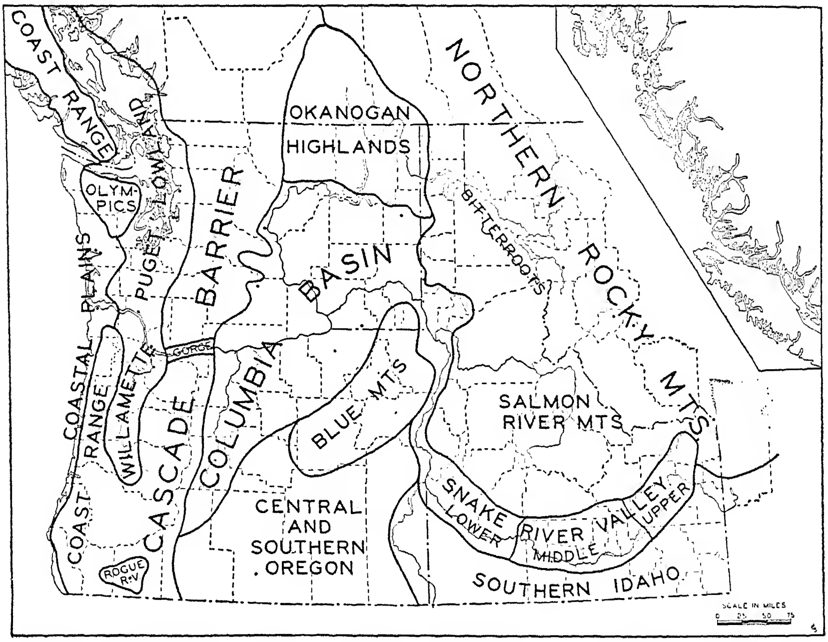

Fig. 32. Northwest physiographic divisions used in climatic classification.

elements throughout the region have obviously affected the natural vegetation, development of relief features, kinds of crops, and numerous human activities. In common with the rest of the world, a number of controls combine to determine the characteristics of the climate in

[1] The writer wishes to acknowledge the helpful assistance of Professor N. F. G. Davis, University of British Columbia, Vancouver, B. C.

All data have been taken from the U. S. Weather Bureau, Climatic Summary by Sections (1, 2, 3, 4, 5, 6, and 7), from "Establishment of Stations up to 1930."

this area Of these the most important are latitude, altitude, relation of land and water masses, ocean currents, mountain barriers, frequency and intensity of storms, frequency and trajectories of air masses, and the local topography Within an area where one type of climate should be expected, the controls may vary so that a number of types result, though they all somewhat resemble the basic climate (Fig. 32).

Classification

The general location of the Pacific Northwest, on the windward coast in midlatitudes, is such that the characteristics of the climatic elements combine to give a type of climate known as "western margin cool temperate" (Herbertson), or "cool marine" (Koeppe), or "western margins of continents in higher middle latitudes" (Jones and Whittlesey), or "Csb" (Koeppen), or BC's (Thornthwaite) The essential features, as denoted by these classifications, are a small annual range of temperature for the latitude, an abundant precipitation, most of which comes during the rather mild winter, a relatively cool summer, a long frost-free season, and wind from off the ocean nearly all year. This type may be considered as the main or basic climate for the whole area Its best development is along the coast, it shows increasing degeneration from the basic type in direct proportion to increasing distance from the coast.

Controls

The latitude determines the seasonal cycle and total amount of heat to be received from the sun. This should yield a mean annual temperature of about 42°,[2] and January and July means of 19° and 65°, respectively, at 50° north latitude But the ocean and its currents and the air masses from over the ocean prevent the attainment of the expected average temperatures. It has been shown by Gerlach[3] that air masses from off the Pacific Ocean are present over Seattle no less than 80 per cent of a normal year. As the air masses flow eastward, their properties are modified and changed by the parallel, high, and continuous mountain ranges which lie athwart the general trajectory of air flow.

The latitudinal shift of the wind belts during the course of the year results in numerous extratropical cyclones in this latitude during the winter, but during the summer the weather is controlled by the Pacific

[2] All temperatures are given on the Fahrenheit scale

[3] Arch C Gerlach, "Distribution of Air Mass Types and Frequency of Change in the Western United States during 1937-1938," *Monthly Weather Review,* Vol 66, 1938.

High, thus the summers are sunny whereas the winters are cloudy In addition to the main mountain ranges, the local topography allows marked differences of weather, particularly temperature, to occur within short distances. This is especially true during calm, clear weather.

The ocean to windward affects the temperature and moisture content of the air traveling across it, the air bringing those acquired characteristics to the land For this region, the control which is next most effective is the mountain barriers which stand so high that the temperatures are materially reduced on their slopes, moisture is wrung from the air on the windward side, and dynamic warming is permitted on the lee side Furthermore, the mountains obstruct the flow and allow only the potentially warmer air from aloft to move to leeward. All these changes occur downwind.

TEMPERATURE

Mean Annual Temperatures

Along the west coast there is little difference in the mean annual temperatures (Fig 33) From Brookings, Oregon (approximately 42° north latitude) to Prince Rupert (approximately 55° north latitude), a difference of 13° of latitude, 900 land miles, the mean annual decreases but little more than 7°, to 45° at the latter station. This temperature difference is about the same as that experienced in a difference of 2,000 feet in the mountains. The flat north-south temperature gradient, owing to wind off the ocean, is in sharp contrast to that along the east coast, where the mean annual changes about 1° per 60 miles.

Inland the mean temperatures are more dependent upon altitude, effect of the mountain barriers, and distance from the ocean Inland the mean temperatures decrease progressively. The lowlands west of the Cascades, the Columbia Basin below 1,000 feet, the Rogue River Valley, and the lower Snake Plains all enjoy temperatures above 50°. The remaining subareas are too high or subjected to too protracted cold winters to average above 50°.

The Columbia Basin between 1,000 feet and 3,500 feet, the Middle Snake Plains, southern and eastern Oregon, the Coastal Range in Oregon, and Idaho bordering on the Columbia Basin are the largest areas which have mean temperatures between 50° and 45°. The Cascades (above 2,500 feet), a portion of central Oregon (above 4,000 feet), the Upper Snake Plain, and mountainous Idaho, Montana, and British Columbia largely experience mean temperatures between 45°

and 40°. The highest mountains and high mountain valleys in Idaho and Montana average below 40°.

Large differences in temperature are found within short distances where the altitudinal difference is appreciable. Between Longmire and Paradise Inn (altitude difference 2,800 feet) the mean drops from 44° to 38°.

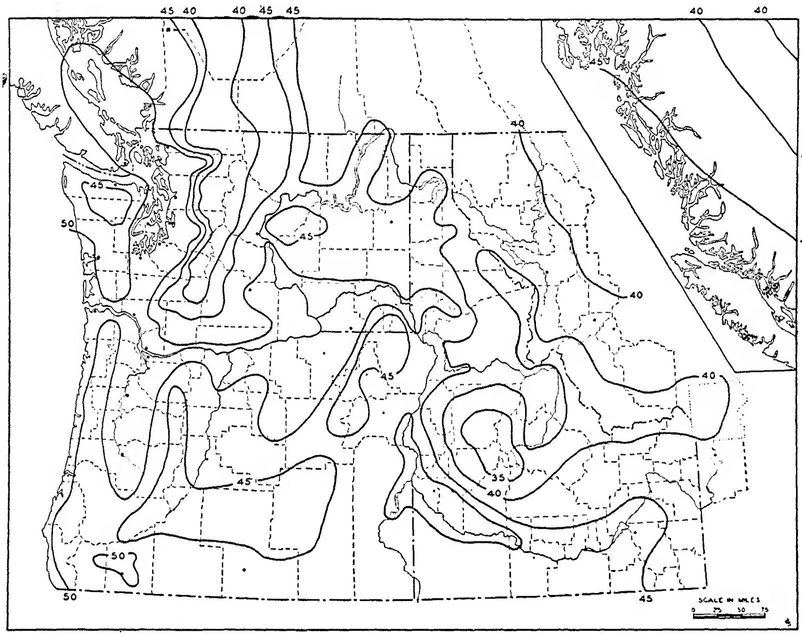

FIG. 33. Mean annual temperatures of Northwest.

Sea-Level Temperatures

By correcting the temperature (Fig. 34) for the altitude of each station above sea level,[4] the effect of the ocean and the mountains on the mean temperature may be shown. Unlike the actual mean annual temperature map, the sea-level isothermal map portrays an increase of temperature from coast to interior. The southwest trend of the isotherms along the coast indicates that the ocean exerts a cooling which is dominant from March to November.[5] The north and northeastward alignment of the isotherms on the lee side (east) of all major

[4] For computing sea-level temperature 0.9° F. for each 330 feet (0.5° C. per 100 meters) was added (see C. F. Brooks, A. J. Conner, and Others, *Climatic Maps of North America*, Harvard University Press, Cambridge, Mass., 1936).

[5] *Ibid.*, Maps 3, 4, 5.

mountain ranges illustrates the barrier effect of the mountains in preventing the flow of cool ocean air during the warm season.

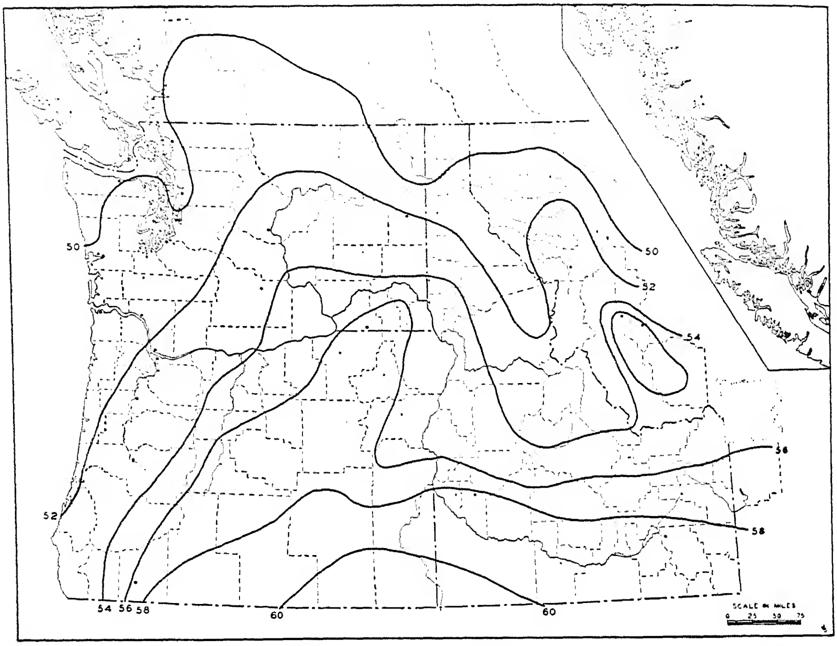

FIG. 34. Mean annual sea-level temperatures.

January Mean

The temperature distribution during January (Fig. 35) shows a great similarity to that of the mean annual, that is, a rapid decrease of temperature eastward and very little increase southward. Within the latitudinal distance there is a difference of only 12°, a remarkably flat temperature gradient for winter in this latitude. The Pacific Coast, even at Prince Rupert, is warmer than any place, regardless of latitude, east of the Cascade barrier. The greatest change of temperature occurs along the windward slopes of the mountains whereas, on the lee side, there is little difference in temperature from the tops of the mountains to the floor of the valley below. This is especially true along the eastern flank of the Cascades. It is caused by an inversion of temperature in the cold, dry air in valleys. It is a common occurrence in winter to find a decrease of temperature as one ascends on the west side of the Cascades and a continued decrease of temperature as one descends on the east side.

Below 1,000 feet in the Columbia Basin the mean temperature

is above freezing. This is largely due to the low altitude and secondarily to the easy access, through the Columbia Gorge, of relatively warm air from the ocean.

The larger valleys do not show such pronounced inversions, and therefore have lower mean January temperature than the high, small enclosed valleys of Idaho and Montana.

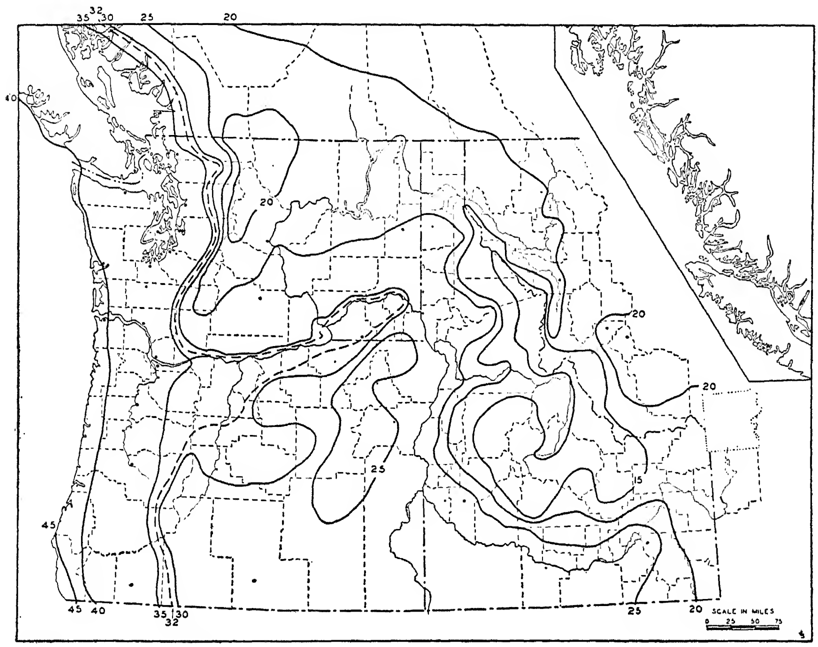

FIG. 35. January mean temperature.

A measure of the continentality of the eastern part of the region is illustrated by the Snake Valley in Idaho. In the western part (altitude between 2,000 and 3,000 feet) the mean temperature is from 25° to 29°, in the middle part (3,000 to 4,000 feet) the temperature is between 25° and 20°, and in the eastern section (above 4,000 feet) the temperature is below 20°.

Lowest Temperatures Recorded

The coldest air (Fig. 36) comes from a traveling polar anticyclone which moves along the eastern edge of this area or to the east of the great chain of the Rockies. This produces a pressure gradient which causes cold, dry, clear air to flow southwestward. Though this happens a number of times each winter, not always does such a flow cover the

whole area The frequency of cold flows decreases from northeast to southwest.[6] As the air flows toward lower latitudes it passes over a surface which is warmer, therefore, the minima temperatures are higher along the California-Nevada border The marine air along the coast keeps surface temperatures so high during the winter (between 40° and 45°) that the cold air is warmed rapidly as it arrives there. Thus, the coast has relatively high minima temperatures

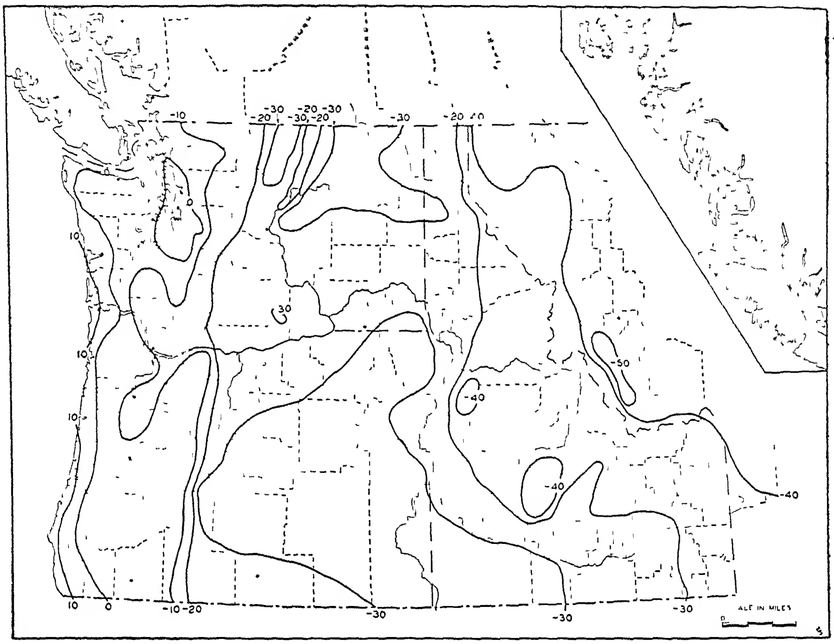

FIG. 36. Lowest temperatures recorded

The most pronounced factor in warming the air in its western motion, however, is the effect of the mountain barriers. Because of the north-south alignment of the mountain ranges only the potentially warmer air, which is above the top of the continuous ranges, can flow over. This air in its descent on the westward slope is then heated dynamically (approximately 5 5° per thousand feet). The higher the mountain the warmer (potential temperature) the air that can flow over and the greater the descent. By damming off the bottom part of the polar air, the mountains thereby increase the temperature as well as reduce the amount of air flowing southwestward This factor materially contributes to the decreasing frequency of polar air from

[6] Arch C. Gerlach, *loc. cit.*

northeast to southwest During a normal winter, air from the northeast reaches Seattle about half a dozen times.

Whenever clear, dry air covers the area it is preceded by a fall of snow which remains on the ground, thus producing the best possible surface for nighttime radiation to lower the air temperature Inversions then develop, and low temperatures are recorded at the valley bottom. The lowest temperatures are in the most protected valleys where there is no wind to stir the air This accounts for the extreme temperatures of Bowen (—55°), Dillon (—52°), and Fortine (—49°) in Montana, New Meadows (—49°) and Obsidian (—44°) in Idaho; Cusick (—36°), Stockdill Ranch—near Winthrop—(—33°), Bumping Lake (—31°), and Wenatchee (—29°) in Washington; and Vale (—39°) and Wallowa (—38°) in Oregon.

Where low gaps form a break in an otherwise continuous barrier, cold air will flow westward when a favorable pressure gradient is present The Columbia Gorge is a major gap of low altitude across the Cascades The lowest temperatures west of the Cascades, Longview (—20°), are immediately tributary to the Gorge, and greater warmth is found in all directions from the south through the west to the north of this orifice. Wind of destructive velocity is often observed in the gorge when the air drains westward [7, 8]

Of lesser influence and effectiveness is the gap in the Fraser River in lower British Columbia The air drainage basin of this valley is much smaller than that of the Columbia Basin Nevertheless, with favorable pressure, cold air flows out as far as Georgia Strait and the San Juan Archipelago and accounts for the low minima (below 0°) in the northern part of the Puget Sound Lowland and southern British Columbia.

July Mean

During this month (Fig 37) the reverse condition from that of midwinter is present; that is, there is an increase of temperature from west to east This amounts to more than 15° from the coast to the Lower Snake Valley, though the latter is more than 2,000 feet high. The difference from coast to inland is largely owing to the blocking mountains and to the aridity of the summer air which permits high daytime maxima

The immediate coast and adjacent portions of the Puget Sound

[7] D C Cameron, "Easterly Gales in the Columbia River Gorge," *Monthly Weather Review* Vol 59, 1931

[8] A B Carpenter, "Subsidence in Maritime Air over the Columbia and Snake River Basins," *Monthly Weather Review*, Vol 64, 1936

Lowlands have temperatures below 60°, the greater part of the Puget Sound Lowlands have temperatures below 65°, but the Willamette and Rogue River valleys are between 65° and 70°. All the Columbia Basin, central and southern Oregon, and the Snake Valley are between 65° and 70°. In western Montana the temperatures are well above 65°.

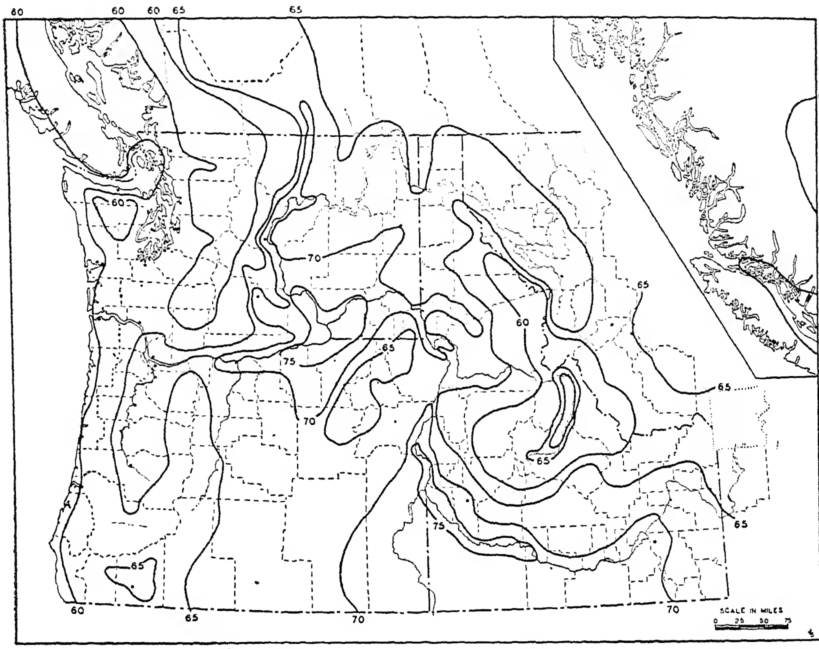

Fig. 37. July mean temperature.

All the higher mountain ranges, the Cascades, Olympics, Coast Ranges, and Rockies, have means of 65° or less. These lower temperatures are solely the result of, and dependent upon, altitude.

The high, enclosed, narrow valleys, by reason of their protected location, have relatively high mean temperatures. An example of this is the upper part of the Salmon River (above 6,000 feet) near Stanley, Idaho, where the mean is well below 60°.

Highest Temperatures Recorded

Because of the usually clear skies during the summer over nearly all the region, high maxima temperatures (100° or more) have been recorded at all stations, except those along the Washington coast and the cold waters of the Strait of Juan de Fuca.

The lower Snake Valley and the lowest part (below 2,000 feet) of the Columbia Basin have experienced temperatures above 110°. Boise stands supreme in having recorded the only temperatures above 120°.

Mean Annual Range

The mean annual range (Fig. 38), difference between the means of the warmest (July) and coldest (January) months, is a measure of the

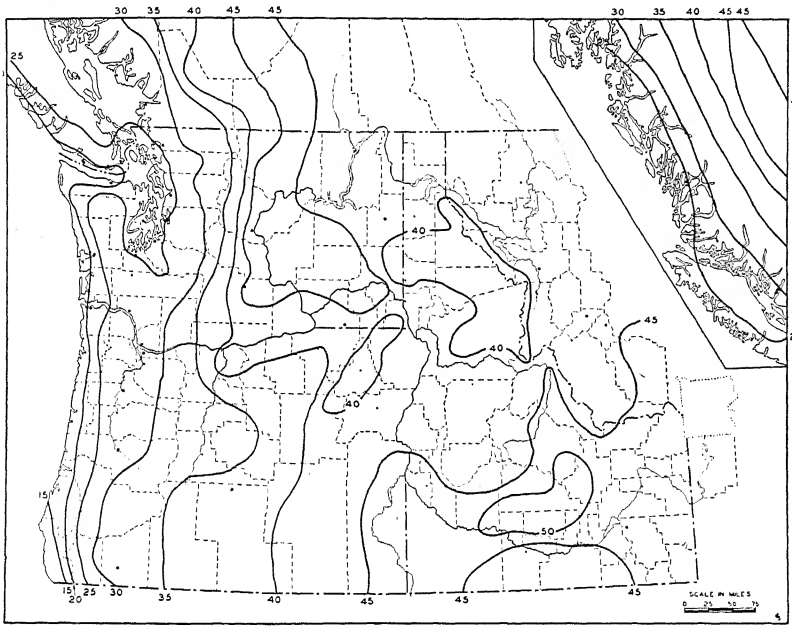

FIG. 38. Mean annual range.

continentality. The annual range along the immediate coast may be considered as purely marine for this latitude because there is little effect of the continent expressed here, especially along the coast of Oregon, south of Toledo, and along the west coast of Vancouver Island, north of Estevan. Along the latter portion of the coast the range is between 18° and 19° and along the former about 15°.

Eastward from the coast the annual range increases to the maximum amount of more than 50° in the middle Snake Valley. The Coast Range of Oregon and the Cascades are marked by an especially steep gradient, again illustrating the effect of the barrier control. Though wintertime temperatures in the topographically lowest parts of the Columbia Basin are nearly those found along the coast, high summer

temperatures produce an annual range of more than 40°. In the higher parts of the interior basins the range is about 45°, though central Oregon, by reason of a somewhat lower latitude, has a range of nearer 40°. This amount, more than double that along the coast, may be considered as a continental range.

Last Killing Frost in Spring

Within the region are wide differences of the average date of the last killing frost in spring (Fig. 39). The station extremes are Febru-

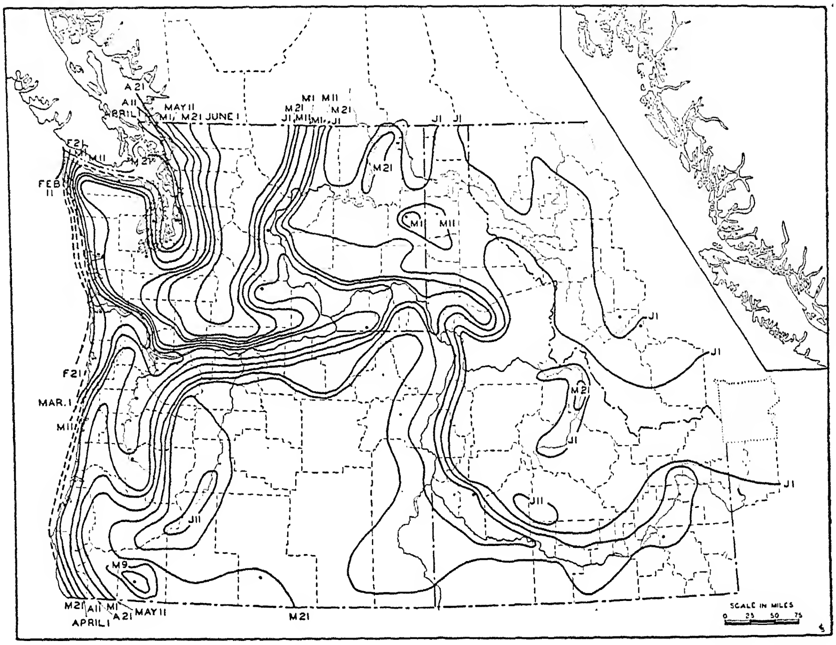

Fig. 39. Last killing frost in spring.

ary 11 at Tatoosh Island and June 28 at Stockdill. The primary controls determining the date for each station are altitude and exposure, except along the coast and the littoral adjacent to the inland waters. Isolines of the average dates, therefore, closely parallel the contour lines.

Along the coast marked differences occur, depending on the distance from the Pacific. A few miles produces differences of a week to a month. North Head, Washington, on the coast, is separated from Astoria by only 10 miles and yet the frost date of the latter is March 8 and the former February 17. On the lee side of the inland waters of

Washington the last frost generally comes prior to April 1 along the immediate shore, but inland a few miles and below 1,000 feet the frost is as late as the last of April. This is true in the lower part of the Columbia Basin also.

Between 1,000 and 4,000 feet in Washington and Oregon, frost occurs any time during May, the earlier dates being at the lower altitude Striking differences in the dates, and therefore stages of vegetative progress, are to be noted within short distances where changes of altitude are great. Snow may still cover the ground at Moscow when the lilacs bloom in Lewiston, 2,000 feet lower The first early vegetables come from Kennewick (altitude 500 feet), which is relatively free of late frosts, the same vegetables come later from the higher locations, where late frosts delay planting. In the Snake Valley, however, by reason of rapid warming in the spring, the last frost may be experienced before May as high as 3,000 feet, and only in the highest enclosed valleys (above 6,000 feet) are the frosts retarded until June.

First Killing Frost in Autumn

The isolines of average dates again closely parallel the contour lines but, for the area as a whole, there is less difference in the dates of the killing frost in the autumn than the last frost in spring (Fig 40)

In Washington, where both the earliest and latest last spring frost occur (4½-month interval), there is a difference of about 3½ months in the autumn frost. This is because autumn frosts occur during clear, calm weather, and nighttime loss of heat is the dominant factor in reducing the air temperatures to freezing. The loss of heat is about equally rapid within the altitudinal range of stations Through this process freezing temperatures result in a valley, whereas the normal decrease of temperature with altitude may bring the slopes of a mountain to freezing temperatures on the same date.

When nighttime cooling reduces the temperature in a valley bottom, somewhat higher temperatures, perhaps above freezing, may result at intermediate slopes The valley side may then have a later first frost in the autumn This is frequently the case in enclosed valleys, irrespective of altitude, but the immunity to frost of the valley sides depends largely on the ratio of bottom width to drainage area of the sides; the narrower the valley, the more pronounced the vertical temperature differences.

The coast has its first autumn frost in late November or early December, so late that cranberries can be grown there The Willamette-Puget Sound Trough and the lower Columbia Basin have their first

autumn frost during the last week of October or first half of November. In the Snake Valley in Idaho the corresponding dates are first week of October, last week of September, and mid-September for the lower, middle, and upper parts. Between 1,000 and 3,000 feet in the Columbia Basin the frost generally occurs in the latter half of Sep-

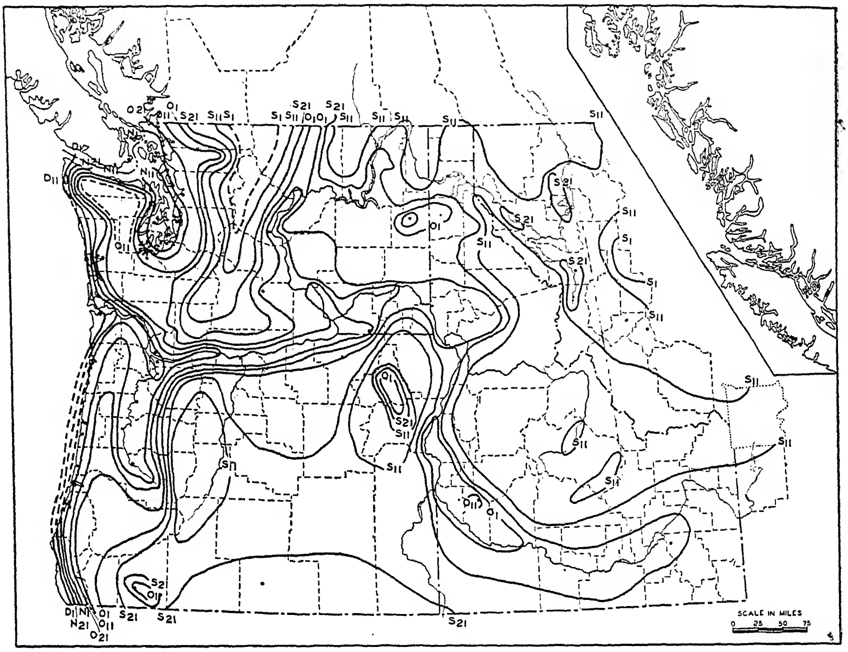

FIG. 40. First killing frost in autumn.

tember, whereas at higher altitudes the arrival may be as early as the second week of September.

Length of Frost-Free Season

The length of the frost-free season (number of days between the date of the average last spring frost and first fall frost) reflects the wide differences of the determining frosts (Fig. 41). The extremes are 68 and 306 days (Stockdill and Tatoosh Island; 200 miles apart; altitude difference 2,200 feet).

The length of the frost-free season clearly demonstrates that east of the Cascade barrier the land is the dominating influence, for example, short season, and that altitude plays an important part in determining whether the season shall be slightly more or much less than 4 months in length. The altitude of the lower Snake Plains is low enough to permit a season of about 5 months, whereas, in the Columbia Basin,

the season is about 4 months. Higher up, the season shortens approximately in direct proportion to altitude.

The coastal plain, except for a portion where the Oregon Coast Ranges abut the ocean, has more than 7 months without frost. This is directly ascribable to the temperature of the winter wind from off the water which is higher than 40°. But the decrease in length, progressively

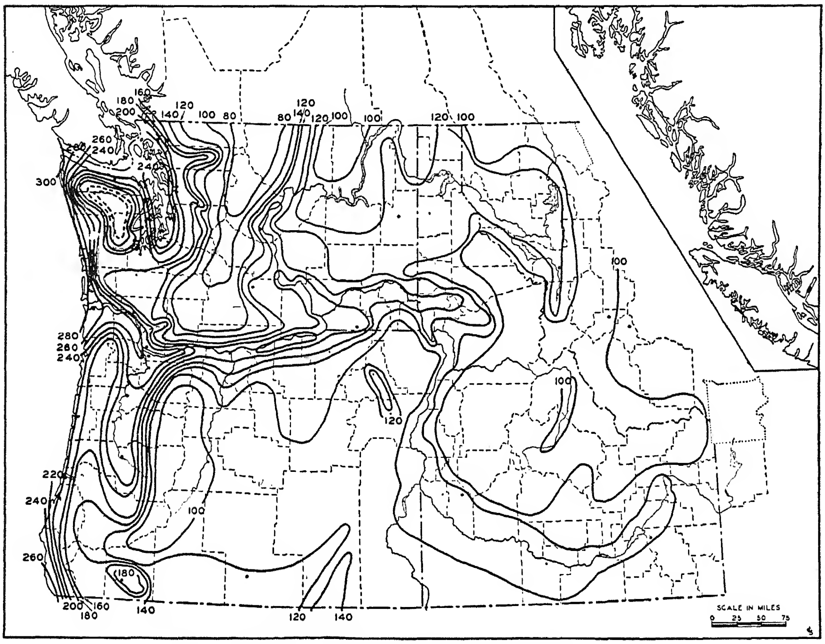

FIG. 41. Length of frost-free season.

inland, is very rapid. Usually within the first 30 miles the season is shortened by a full month.

The Puget Sound Lowland and Willamette Valley show marked differences within short distances but the average season is about 7 months in length. The differences depend upon the location of the stations; for example, city or country, hillside or valley bottom, close to or few miles from water (Puget Sound, Strait of Juan de Fuca, Columbia River, etc.). Thus local topography and proximity to water bodies produce or prevent a long frost-free season here.

PRECIPITATION

Mean Annual Precipitation

The outstanding characteristic of the precipitation (Fig. 42) over the whole area, except western Montana, is that more falls during the

colder half year (November through April) than during the warmer half year (May through October). The colder half-year proportion decreases from west to east. Because one of the criteria of a marine climate is that greater precipitation occurs in winter than summer, the whole region has a marine precipitation regime as far inland as the Bitterroot Range. To the east of that barrier, a continental precipitation regime holds sway.

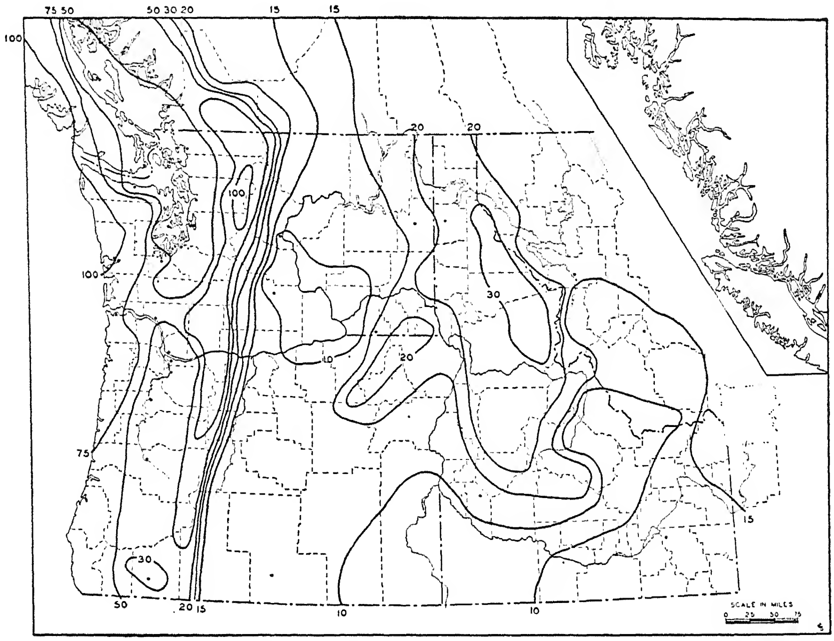

FIG. 42. Mean annual precipitation.

North Head, Washington, is the best example of a station along the coast least influenced by mountains. Its annual total (approximately 50 inches) indicates the amount that occurs along the coast at sea level. The recorded falls at other stations, being considerably more than at North Head, demonstrate that the amount is affected by the mountains.

The windward slope of the mountains (southwest) causes ascent of the unstable and nearly saturated[9] maritime air. This results in copious precipitation on the western slopes. North of the Columbia River

[9] H. C. Willett, "American Air Mass Properties," *Papers in Physical Oceanography and Meteorology*, Vol. II, No. 2, p. 30, 1933, Massachusetts Institute of Technology and Woods Hole Oceanographic Institute.

more than 100 inches is common, it is here that the greatest amount of precipitation occurs in North America.

The first mountain ranges receive the largest amount, and succeeding ranges (downwind) receive somewhat less The precipitation then is governed largely by altitude

The lee slope permits descent of air or increases the distance through which the rain must fall. The greater the latter distance, the greater the precipitation that evaporates and the less that reaches the surface of the earth. If the air on the lee slopes is actively descending, it is becoming warmed and, therefore, is a drying wind from which no precipitation can come Thus, the lee slope receives less precipitation, and the mountain casts a shadow of less rain. Paradoxically, this has been termed a "rain shadow", a better term is "dry shadow." These shadows are very definite in the Northwest, especially in the lee (northeast) of the Olympics where the annual amount is less than 20 inches (Sequim, etc).

The Cascades cast a "dry shadow" of considerable importance because the Columbia Basin is lower than the Cascades. The rainfall decreases with diminishing altitude in all directions to a minimum of about 6 inches just north of the confluence of the Snake and Columbia rivers The low plains of the Columbia Basin, together with central and southern Oregon that receive less than 10 inches a year, form interior deserts The Northern Rockies and the Blue Mountains proper, because of their altitude (equal to or higher than the Cascades), are more favored with precipitation, averaging 15 to 50 inches In the lee of these mountains, or any of their spurs which lie athwart the moist westerly winds, are local "dry islands." Of these the largest is the Snake River Plain Here again the altitude is the main factor determining the amount, for the lower portion receives about 10 inches or less, the middle 10 to 13 inches, and the upper portion more than 13 inches.

From the above it follows that the isohyets will generally parallel the coast and the windward slope of the mountains, but will cut across the mountain gaps, for example, Straits of Juan de Fuca, Columbia Gorge On the "shadow" side the isohyets will more closely parallel the contours, with the least rain at the lowest altitude.

Because the precipitation comes during the colder half year, it is associated with traveling depressions which cross the Pacific from the China Sea.[10] The annual north-south swing of the normal cyclonic trajectory and the annual cycle of change in intensity of these storms

[10] H G Byers, "Air Masses of the Pacific," *Bulletin of Scripps Institute of Oceanography Technical Series*, Vol 3, No 14, p 321, 1924

provide little cyclonic precipitation during the warmer half year. The summer, though sunny and hot east of the Cascades, is relatively free of convectional storms because the air is too dry. Only small cumulus clouds (alto cumulus) can develop from daytime convection except where the air is ascending the higher mountains. Here summer thunderstorms are relatively frequent. The coolness of the lowlands west of the Cascades is so detrimental to convectional activity that only a few mild thunderstorms occur each year, and these are the result of frontal movements associated with cyclones.

Snowfall

With winter sea-level temperatures near freezing and with maximum rainfall during the colder half year, it is to be expected that at mod-

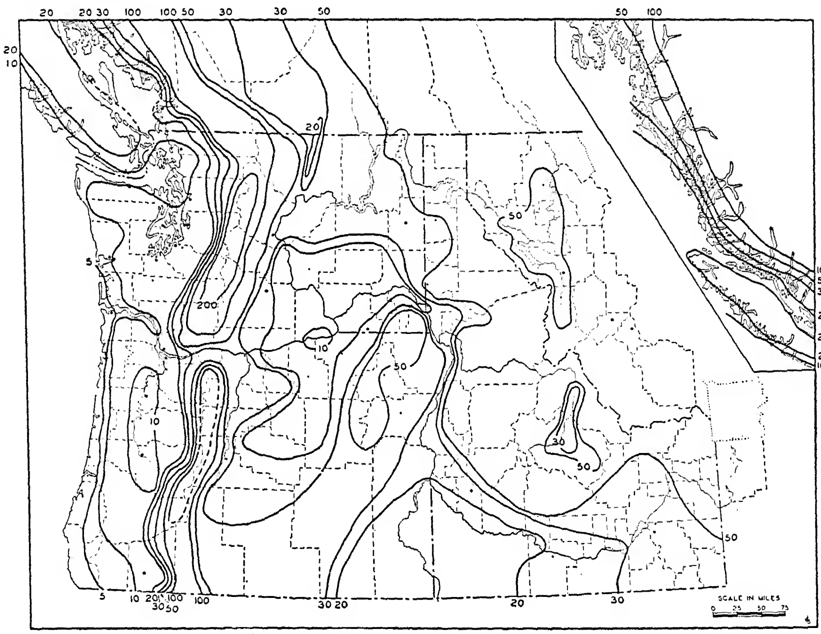

FIG. 43. Snowfall.

erate and high altitudes, and especially on the windward slopes of the mountains, much of the precipitation will be in the form of snow (Fig. 43).

Along the coast there is little snow (average is about 5 inches) because of the lack of cold waves from the interior reaching so far west. The lowlands west of the Cascades, which are colder than the Pacific

Coast Plains, have an average of about 10 inches Even this is a small amount compared to the total rain during the same period Here, as along the coast, there are few flows of cold air from the east to produce the necessary cold for snow

Undoubtedly, considerable snow falls on the higher slopes of the Olympic Mountains—sufficient to allow snow fields and small glaciers to be present in spite of altitudes below 8,000 feet. In the Cascades the amount depends almost entirely on altitude and exposure, with an increasing amount being recorded up to a height of 5,000 to 6,000 feet The zone of maximum amount may be above that, but, at present, there are no recording stations above 6,000 feet At 500 feet (Snoqualmie Falls) the winter total averages 16 inches, at 3,000 feet (Snoqualmie Pass) nearly 400 inches, at 4,400 feet (Mt Baker) 492 inches, and at 5,500 feet (Paradise Inn) 591 inches Because of the great depth of snow in the Cascades, the State Highway of Washington finds it feasible to keep but one route over the mountains (Snoqualmie Pass) open all winter.

East of the Cascade barrier the amount decreases rapidly. In the Columbia Basin there are 10 to 35 inches, the amount increasing in all directions from a point near the confluence of the Snake and Columbia rivers.

In the Blue Mountains and Northern Rocky Mountain areas, the winter's fall is well above 50 inches, and in higher places the total may be more than 200 inches In the mountains, railroads must build many miles of snow sheds and maintain snow-removal equipment to keep the rails open during the winter As with rainfall, deep, enclosed valleys receive less snow than the surrounding mountains.

In British Columbia the situation is the same; to wit, about 10 inches on the immediate coast and a rapid increase of total fall with higher altitude At Premier (altitude 1,371 feet) the total is 466 inches.

The duration of the snow cover is somewhat proportional to the total amount The lowlands, west of the Cascades, and the coastal plain have snow on the ground less than 5 weeks. This duration increases to 10 weeks in the lower part and to 15 to 20 weeks in the upper part of the Columbia Basin. In all the mountains where the snow depth is 50 inches or more, the duration on the ground is more than 20 weeks On Mt. Baker (4,400 feet) and Mt Rainier (5,500 feet) the season is at least 40 weeks long Above 8,000 feet snow lies on the ground all year

The amount of snow is of utmost economic value especially for irrigation where natural precipitation is insufficient, and also for hydroelectric power All irrigated districts are entirely dependent upon

the snow melt, which is at a maximum at the time that the greatest amount of water is necessary for the growing crops Because of this characteristic, it is not essential to store much water for the irrigating season and irrigation costs are relatively low.

The water power developed, and to be developed, is also largely dependent on the runoff of snow melt That this maximum hydro-electric power should be maintained all year it is necessary to provide reservoirs to even out the early maximum discharge of the rivers

In the Northwest numerous snow courses have been established where snow surveyors are busy in late winter measuring the water content of the snow cover to determine how much water will be available for irrigation, power, and other uses during the following dry season.

Sunshine and Cloudiness

From the records of the few weather bureau stations that record sunshine and cloudiness it is possible to conclude that along the coast and the lowlands west of the Cascades the average amount of sunshine is 40 to 45 per cent of the total possible. This figure would be further decreased in the coastal mountains, probably to 30 per cent East of the Cascade barrier in the Columbia Basin, northern Idaho, and western Montana the yearly average is 52 and 59 per cent In the Snake Valley, as represented by Boise, the high value of 65 per cent is realized.

Winter is the least sunny season over the whole area Along the coast the sun shines about 20 per cent of the total possible time, and this amount increases slightly in the lowlands west of the Cascades In the Columbia Basin, northern Idaho, western Montana, and the Snake Valley the percentages are 28 to 43 per cent.

Summer is the sunny season. Seattle and Portland report an average of 60 and 64 per cent, Spokane and Baker 77 and 75 per cent, Kalispell and Helena 69 and 70 per cent, and Boise 84 per cent.

Crops grow rapidly during the sunny summer and produce large yields when irrigated (two to four cuttings of alfalfa can be made, depending on the district). In appearance of the fruit and quality of the grains these crops are superior to crops raised in less sunny areas. Fewer pests and diseases attack the crops than in cloudier climates.

Wind

The mountain-valley character of the topography of the region, with the observing stations in the valleys, materially reduces the validity of wind observations because the surface wind will largely be directed

either up or down the valley. For general wind directions isobaric charts of the average pressure then give a truer picture These charts show that during the winter season the wind is from the southwest to south and in the summer from northwest to west. These directions are consistent with the rainfall regime, southwest wind has a high moisture content and is unstable (therefore rainy), and the northwest wind, being cooler than the surface over which it is traveling and descending (therefore warming), is dry.

Many local winds of all types are to be found because of the topography, mountain barriers, juxtaposition of land and water, snow surface versus bare ground, and mountain gaps of all sizes in addition to rapid changes in steepness and direction of the pressure gradient Among them may be listed the following, the places where found, and season of occurrence.

Sea breezes (Land breeze seldom observed because the water is too cold)—Along the coast and the inland waters (summer)

Valley breezes—Any mountain valley (warmer half year)

Mountain breezes—Same as above

Fall (katabatic or gravity) *winds*—Any mountain valley which opens out to a high, wide, snow-covered, large alpine meadow (spring and summer).

Gorge winds—Fraser, Columbia, Snake, Thompson, and other rivers, Straits of Juan de Fuca, fiords of British Columbia (any season)

Chinook (Foehn) winds—On the lee side of any mountain, provided precipitation (rain or snow) falls on windward slope EXAMPLES A descending wind on east side of Cascades in winter, descending wind on west slope of Bitterroots or Cascades if snow or rain has fallen on east slope of the Rockies (rainy season).

Conclusions

The location of the Pacific Northwest in midlatitudes on the western margin of the continent with resultant onshore wind yields a marine climate. The distinctive characteristics of this basic type are greatly modified by distance from the coast, differences in altitude, mountain barriers, and local topography. The modifications are all toward increasing aridity and continentality, except on the windward slopes of the mountains, and are so pronounced that all marine characteristics have been obliterated on the eastern boundary of the area. As a result there is a large number of climatic types (Fig 32)

The number of the climatic types and their characteristics have produced nearly all types of soil from the most acid to the most alkaline The Northwest has the greatest commercial forests in the world (more board feet per acre), excellent grazing land, and even

TABLE 3

SUMMARY TABLE OF CLIMATES OF THE PACIFIC NORTHWEST

Physiographic Regions	Climatic Areas	Temperature °F				Precipitation*		Per Cent of Sunshine	Length of Growing Season (Days)
		Mean	Range	Jan	July	Total—Inches	Total Snow Inches		
Plains									
Willamette Valley	Willamette-Puget	more than 50	25 to 30	35 to 40	60 to 70	20 to 50	5 to 15	40 to 45	180 to 200
Puget Sound Lowland	Sound Lowland								
Pacific Coast Plain	Coastal Plain	50	15 to 20	40 to 45	55 to 60	50 to 150	0 to 8	30	180 to 310
Columbia Plain	Columbia Basin	45 to 50	30 to 45	25 to 35	68 to 77	5 to 17	10 to 40	50 to 60	130 to 210
Channeled Scabland									
Snake River Plains	Snake River Valley	40 to 50	45 to 50	15 to 30	68 to 77	8 to 15	10 to 50	60 to 65	100 to 170
Rogue River Valley	Rogue River Valley	more than 50	30	35 to 40	65 to 70	20 to 30	10 to 20	60	180
Plateaus									
Yakima Folds									
Deschutes Plateau									
Tri-State Slopes	Columbia Basin	45 to 50	35 to 45	25 to 35	63 to 77	10 to 20	10 to 55	40 to 60	80 to 200
Palouse									
Waterville									
Owyhee Plateau	Central and Southern Ore.,	45 to 50	45	30	70	10	10 to 20	60	120 to 140
Basin and Ranges	and Southern Idaho		40	25 to 30	65 to 75	10 to 15	10 to 55	60	80 to 150
Mountains									
Olympics	Olympics				50	30 to 200	8 to 300	30 to 40	80 to 120
Oregon Coast Ranges	Coast Range		25 to 35	25 to 35	65	40 to 150	5 to 300		100 to 150
Vancouver Island									
Cascades	Cascade Barrier	35 to 45				40 to 100	15 to 600	30 to 45	80 to 120
Okanogan Highlands	Okanogan Highlands					10 to 20	15 to 60	50	80 to 150
Blue Mountains	Blue Mountains		35 to 50	10 to 25	55 to 65	15 to 20	40 to 100	45 to 50	100 to 160
Northern Rockies	Northern Rockies					10 to 20	40 to 100	50 to 55	80 to 140
Middle Rockies	Southern Idaho					10 to 15		55 to 60	

* Throughout the Northwest the greatest precipitation occurs in the colder half of the year in all regions except the northern and middle Rockies, where it comes in the warmer half of the year as a result of continental influence

alkaline flats, all of which are the result of native vegetation controlled by climate and soil.

Each climatic type will permit certain activities, will tolerate some and will restrict others. This is particularly true of all forms of agriculture and, to a lesser extent, of many other human endeavors. The large number of climates, each with its distinctive characteristics, has passively permitted or actively demanded the wide range of activities to be described in later chapters.

PART III

EXPLOITATION AND CONSERVATION OF NATURAL RESOURCES

CHAPTER 5

PACIFIC NORTHWEST SOILS

By C. E. Deardorff and W. A. Rockie

One hundred years ago the Pacific Northwest was a wilderness of timber and of grass. Bare land was virtually nonexistent. West of the Cascades nearly every acre was tree covered. East of the Cascades the grassy sage-covered basins of the Columbia and Snake rivers were interspersed with, and surrounded by, pine-covered mountains and hills.

The only unclothed areas in the entire region consisted of a few "sore spots" of raw sand dunes along the ocean front, the Columbia River, and in a few of the driest inland spots, an occasional recently burned forest or grassland area and some above-vegetation-line mountain peaks. These exceptions made up a negligible percentage of the total land area. The region otherwise was perfectly and completely clothed by nature's plant species.

Under such cover, the soils of the region developed slowly from the original mantle of relatively inert soil particles. During recent periods, at least since present climatic conditions have prevailed, the rate of soil formation has exceeded the rate of geological erosion sufficiently to have developed a mantle of mature soils over most of the lowlands and the gentler slopes. The steeper high mountains generally have a rather thin, and usually a less mature, soil mantle.

The soils of the Northwest are highly variable.[1] They vary with the geological formations and with the topography, the precipitation, the temperature, the humidity, the winds, the sunshine, the cloudiness, the degree of surface drainage, and the character of the plant cover under which they have developed.

If each physical and chemical difference in the soil was the basis for designating individual soils, every farm would have a different soil for each sample studied. Technically this would be true if 100 or even 2,000 samples to the acre were used. A lifetime could be spent describing and differentiating the soil variables in a single small valley or even on a single farm. Two soils are no more alike than two human beings

[1] The chart, pages 144-145, will be found useful in helping to distinguish between types and technical terms.

are alike. Soils may be similar, but nature never makes two alike. Such a limitless number of soils makes necessary, for any generalized study, the grouping of similar, though different, soils into groups or classes

Since soils are different individually, they must receive individual treatment in order to attain the best results. The best handling of soil is attained only after an intimate acquaintance has been gained with any tract of land Every farmer knows of certain spots on his farm to which he would give individual treatment if he had time A low spot may be so soggy that it delays the plowing of an entire field A clayey hillside may permit of proper tillage only under certain moisture conditions. If the land is tilled when either too wet or too dry, there is trouble

Most portions of an average field on good farm land are sufficiently alike, however, so that the entire field usually is farmed with uniform cultural treatments Soils, like people, respond better under individual consideration and treatment. Some soils, like some people, will stand more abuse than others. Some soils will stand more cultivation, more pulverization, or more cropping without apparent damage, other soils show an instant and unmistakable reaction to ill treatment.

The units of classification used in discussing characteristics of soils are grouped into two principal categories (1) series and (2) types.

The series is a group of soils having genetic horizons of similar character with respect to differentiating factors, and, except for the texture of the surface (which determines the type), these soils have morphological features of close similarity

ORIGINAL CONDITION OF SOILS IN THE NORTHWEST

Parent Material

Basaltic bedrock dominates more of the land area in the Northwest than any other class of rock. It underlies most of the land area between the Cascades and the Rocky Mountains and is common in other parts of the Northwest. The Cascades are volcanic except for a part in northern Washington, whereas the Coast Range consists dominantly of dense sedimentary and eruptive rock and the Rocky Mountains are dominated by granitic types with remnants of old sedimentary cover rock

Superimposed upon thousands of square miles of both lowland and upland areas within these three general areas of different types of bedrock (basaltic plateau, Cascade and Coast ranges, Rocky Mountains) are extensive areas of loosely consolidated or unconsolidated lacustrine, alluvial, or wind-blown sediments. In fact, probably two-thirds of the area within the region has a more or less uniform mantle

of this secondary material. This is particularly true of the lands that are used for any phase of agriculture. The basaltic plateau usually is thinly covered with these deposits, and all the major valleys and many of the lesser depressions within the Cascades, the Coast Ranges, and the Rocky Mountains are similarly mantled Even some of the mountain slopes are covered by secondary sedimentary material, although most of them have soil that is thin and largely residual.

Soil Textures

Textures of the soil range from highly colloidal clays to coarse sands and gravels In the basins of the Columbia and Snake rivers, the soil textures are generally sandy along the western border, becoming finer toward the eastern limits. In general, the soils along the eastern border of these basins are loams, silt loams, and silty clay loams. West of the Cascades, soil textures in the glaciated portion are extremely variable, ranging from gravel to sand to clay. The nonglaciated portion, in which most of the west-side agriculture is located, is dominantly the heavier-textured soils, chiefly silt loams and clay loams In the Rocky Mountain area, the soils are dominantly sandy in character Heavy-textured soils are the exception.

Soil Profiles

The profile of a soil displays the different zones or horizons from the land surface downward into the unaltered parent material. Soil students recognize three separate horizons (A, B, and C) in soils (Fig 44).

Horizon A is the upper or surface layer from which natural factors are removing, through leaching and gravity, certain important chemical and physical constituents of the soil material

Horizon B underlies this upper layer and receives, through precipitation and deposition, the materials that are being leached and washed downward from horizon A

Horizon C is the underlying parent soil material, relatively unaltered by these weathering processes.

Development of soil profiles is a slow process, even under the humid climatic conditions in western Washington and western Oregon It proceeds still more slowly under the semiarid conditions east of the Cascade Mountains A study of the actual development of a mature soil, beginning with a newly exposed inert soil material (now found only as horizon C), would require a period of at least several hundred years to accomplish No such sustained study of the actual development of a certain soil has been made, nor is such an accomplishment likely.

Adaptations of this principle, however, are being made by actually studying the horizontal development of the current stages of differently aged soils. By interpolation and interpretation, the desired information is attained.

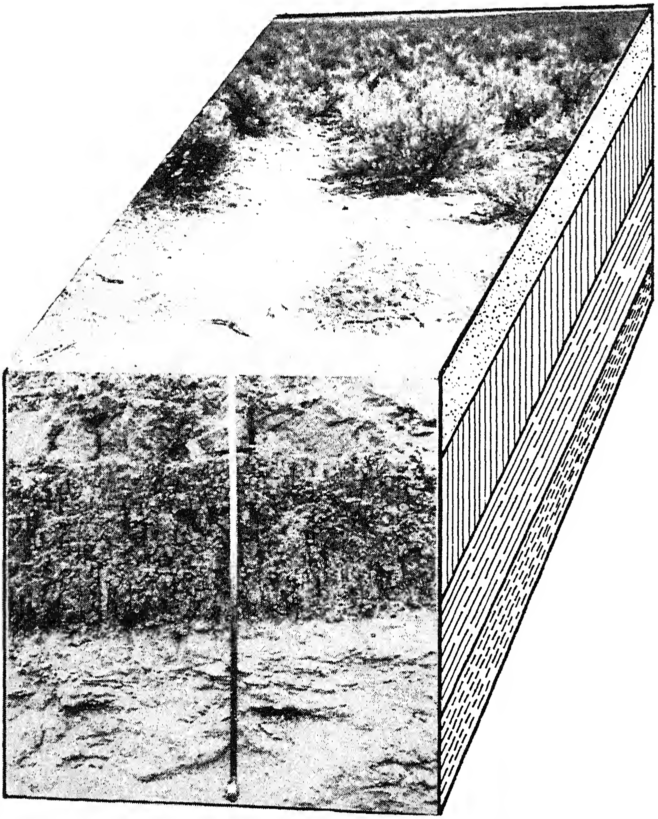

FIG. 44. Soil profile.

Soil Is Alive

The soil is a *living* thing. It is not just "dirt" or "dust." It is a resultant from weathering, washing, blowing, glaciation, or from a combination of several of these natural processes. To many persons, soil is merely something that sticks to one's shoes when it is wet or something that is difficult to remove after it dries; something that gets into one's eyes, ears, nose, and mouth when it blows. This, however, is soil "out of place." When it is producing plants, soil is "in place."

Soil is always developing, always changing. It is never static. This change may be from youth to maturity in one soil, while a near-by soil is developing from maturity to old age.

Effect of Plant Growth

When the land in the Northwest was first exposed to weathering, the soils had no profiles. There were no fungi, no bacteria, and probably no insects. There was no vegetation on the soil, and there was probably no animal life. All these spread into the area and gradually attained their present development after a long succession of changes. The land undoubtedly passed through many stages of plant succession between the original barren uplifted sea or lake floor or wind-blown deposit and the grass or tree-covered land that history first records.

The growth of plants, with whatever climatic conditions accompanied that growth, started the development of soil from the relatively inert parent material. The original and the succeeding plant types slowly added organic content to the soil. Roots penetrated the surface soil while surface portions of these plants developed a litter. More and more roots grew and died, every change making for an ever more mellow and "living" soil.

A close microscopic study of the soil is much more interesting than one would imagine. Almost any soil contains live roots which vary in size from the finest root hairs to large roots. It contains an almost infinite variety of dead and decaying roots, whereas the older organic materials (or sometimes it is the less stable portions) have entirely lost their original physical form. This material is humus. One can see the results of the changes in the soil attributable to bacteria, to insects, to the digestion of soil by worms and other life, and to the loosening of the soil by plant roots and by freezing.

During the period of natural soil development, all soils become more porous, more mellow, and more spongelike. In any particular locality, the degree of soil development depends upon several factors, namely, the characteristics of the parent soil material, the length of time during which development has taken place, the character and density of the vegetation growing thereon, and the climatic conditions. This is not simply a matter of

A clay soil × a period of 5,000 years × a 20-inch rainfall × a 45-degree annual temperature × a 30 per cent cloudiness

It is far more complex. The results depend upon intimate details of how, when, where, how fast, how prolonged, and how regularly changes in the precipitation, the temperature, the sunshine, and the winds occur. An actual formula undoubtedly exists, but our knowledge of the several factors is still far too incomplete to express the conditions as a mathematical formula.

By the time the white man took the country, almost all the land was

more or less heavily covered with grass or with trees or with both. This account brings the land up to our present period of development.

SOILS

The Pacific Northwest is characterized by wide variations in climate, natural vegetation, geological origin of surface deposits, topography, and drainage. These conditions profoundly influence the individual characteristics of the soil and its agricultural adaptations and crop value. A system of soil classification is a valuable aid to the study of the inherent characteristics and agricultural adaptations of the individual soil.

There are many different ways of grouping soils according to the purposes to be served. Two well-recognized classifications will be of value in a discussion of the soils of this region (1) geographic and (2) taxonomic. The geographic group as considered here includes soils of close geographic relationships, particularly as such characteristics determine their use adaptation The taxonomic grouping established by Dr Marbut is designed to place soils having similar morphology and theoretically similar genesis in the same groups (Table, pages 144-145) From the standpoint of soil types, the region has been divided into six major areas, corresponding closely to zones that have similar climatic conditions, common natural vegetation, and use capabilities, as follows:

- I Palouse-Walla Walla Area
- II Columbia-Snake Plateau Area
- III. Coastal Valleys and Foothill Area.
- IV Intermountain Basin and Plateau Grassland Area.
- V Mountain Forest-Grass Area
- VI Mountain Forest Area

Palouse-Walla Walla Area

The Walla Walla, Athena, Palouse, Thatuna, Nez Perce, and similar soils lie mainly in the 14- to 25-inch rainfall belt of the Columbia Plateau wheat section of eastern Washington, northern Idaho, and northeastern Oregon, with small areas in the foothill plateaus of southeastern Idaho They occupy narrow belts of rolling prairie uplands roughly parallel to the yellow pine-timbered low mountains which rise above them. The elevation ranges from 700 to slightly over 3,000 feet in Washington, Oregon, and northern Idaho, and from 3,500 to 6,000 feet in southern Idaho. Native vegetation consists principally of dense stands of bunchgrasses and their climax associates. The cultivated land is devoted chiefly to grain production and constitutes one of the most

productive wheat areas in the Northwest, certainly, and probably in the entire world.

The aforementioned soil groups represent progressive degrees of soil development from youth to age and degradation under increasing rainfall and soil-maturing conditions from west to east.

Walla Walla Series. The soils of the Walla Walla series have been formed from wind and water-laid sediments under conditions of weathering productive of zonal pedocals They show the least mature profile development of any upland group The series is characterized by mellow pervious profile, brown to dark brown noncalcareous soils, with lighter brown, friable, subsoils that become slightly calcareous lower down

The topography ranges from nearly level to steeply sloping The climate is semiarid with a rainfall of 14 to 18 inches Elevation is 1,000 to 2,000 feet Wheat is the principal crop, and high yields are the rule. Forty bushels per acre or more are common yields The farming system is wheat-summer fallow, and, because of long periods of exposed bare soil associated with this practice, wind and water erosion are serious problems The friable character of the lower horizons makes deep gullying a serious menace on the more sloping areas. Gullies several feet deep often result from one runoff period

Athena Series Closely associated with the Walla Walla soil series is the Athena series, representative of a slightly more mature soil than the Walla Walla Athena series soils are intermediate in character between Palouse and Walla Walla soils They are dark brown soils developed under grass cover and under the influence of slightly more rainfall than the Walla Walla, but less than the Palouse The surface soils have a high content of organic matter and are easily cultivated They have clay loam subsoils and silt loam lower subsoils and are noncalcareous to a depth of 50 to 60 inches, where a slight accumulation of lime occurs. They lie at elevations usually slightly higher than the Walla Walla. The soils are among the best wheat soils in eastern Washington and Oregon.

Palouse Series The Palouse soils are most extensively and typically developed in the rolling plateau of Whitman and Spokane counties, Washington The surface of the loessial and water-transported soil is rolling In some sections the topography appears to be the result of water erosion, in other places it has dunelike appearance with steep north and east slopes and more gentle south and west slopes. The soils lie at elevations of 1,500 to 3,000 feet above sea level, usually higher than the Athena soils and somewhat lower than the Thatuna The

climate is subhumid with slightly higher rainfall than the Athena, ranging from 18 to 22 inches

The surface of the Palouse soils is a dark brown, friable, and granular material Silt loam is the predominant surface texture The subsoil is a tough, brown to yellowish-brown clay loam underlain by yellowish-brown silty clay loam, generally noncalcareous except in lower depths

The Palouse soils are highly productive wheat soils The general agricultural practices associated with summer fallow-wheat farming and with wheat and pea farming are the main contributing factors to the deterioration of this soil through erosion.

Thatuna Series. Soils in the Thatuna series are derived from water and wind-deposited material and have a more maturely developed profile than the Palouse They are differentiated from the Palouse series by slightly lighter surface color, the occurrence of a compact leached gray subsurface layer and compact clay subsoil

They occupy a narrow belt adjoining the timbered higher mountain slopes at an elevation of 2,000 to 4,000 feet Rainfall is 20 to 30 inches This series falls in the category of degraded chernozem

Wheat is the principal crop on rolling hills originally covered with a bunchgrass type of vegetation. The somewhat impervious nature of the soil profile and the wheat-summer fallow rotations have caused erosion to be well advanced.

Columbia-Snake Plateau Area

The soils of the Columbia-Snake plateau area are derived from wind- and water-deposited material and have been developed under lower rainfall conditions than the Palouse-Walla Walla soils They have lighter brown to grayish-brown surface, less mature development, and a higher concentration of lime near the surface Two series groups dominate the agricultural lands of the area Group one has permeable subsoils with lime concentrations at varying depths, and group two has compact subsoils and similar lime concentrations.

Ritzville Series The Ritzville series of the mellow subsoil group is the deepest leached member of the two groups and has been developed under slightly more rainfall than the Wheeler series or its compact subsoil counterpart, the Portneuf series.

Ritzville loam, the most extensive type of this series, has a light brown loam of uniform mellow surface The profile shows little difference between soil and subsoil, except that, below 30 inches, concentration of calcium carbonate begins. The topography is undulating to rolling Elevation ranges from 500 to 1,500 feet in Washington and Oregon, the area of principal development Rainfall is 10 to 14 inches.

These soils give moderate yields of wheat under favorable conditions and are subject to both wind and water erosion.

Wheeler Series The Wheeler series includes light-colored soils developed under slightly less rainfall than the Ritzville This series is essentially unleached, showing concentration of lime carbonate in the surface few inches and differing in this respect from the slightly deeper-leached Portneuf Wheeler silt loam is a light grayish-brown, mildly calcareous silt loam, when moist the color is light brown The profile differs from Ritzville mainly in color and lime concentration. This soil is well adapted to crop production under irrigation but under dryland conditions is generally marginal for cultivated crops, being devoted mostly to range. The topography is gently sloping to steep, and was originally covered with bunchgrass and sagebrush Rainfall is 5 to 10 inches Erosion is a serious problem under all conditions of present use.

Portneuf Series. The Portneuf series, the most extensively mapped soil of the compact subsoil group, is distinguished from the Wheeler in the slightly deeper leaching and greater compaction in the subsoil The topography is gently sloping to rolling and in general is favorable for cultivation under irrigation The unleached series of this group have not been mapped and correlated, but are extensively developed in southern Idaho They differ from the Portneuf only in depth of leaching, being calcareous in the surface horizon Except in minor crop difference, they have the same topography, crop adaptation, and erosion hazards as the other soils of this group

The soils of this group are classified as pedocals, the Ritzville being included under the Brown soils group and the other members being Sierozem The latter are arid, developed under a rainfall of 5 to 10 inches, and have a native vegetation of desert shrubs Their use is range for livestock except under irrigation development, when they are classed as highly productive soils. The Ritzville includes the main area of low rainfall wheat land of central Washington and northern Oregon Yields are moderate to low, however, large-scale operations are successful Grazing, irrigation, and extensive wheat farming are contributing to a serious problem of soil erosion and moisture conservation

Coastal Valleys and Foothill Area

The soils of the area west of the Cascade divide fall into three broad groups of pedalfers (humid climate soils)—the "red hill" soils of western Oregon and southwest Washington, the glaciated soils of northwest Washington, and alluvial soils The "red hill" soils are residual, de-

veloped mostly from basic igneous and from sedimentary rocks. The Aiken and Olympic series are the dominant soils derived from igneous rocks, the Melbourne and Carlton series from sedimentary rocks.

Aiken Series. The Aiken series is one of the most productive hill soils west of the Cascades. Apparently they are red, slightly Podzolic soils developed on lateritic parent materials and are related to the Olympic and associated with the Melbourne soil derived from the

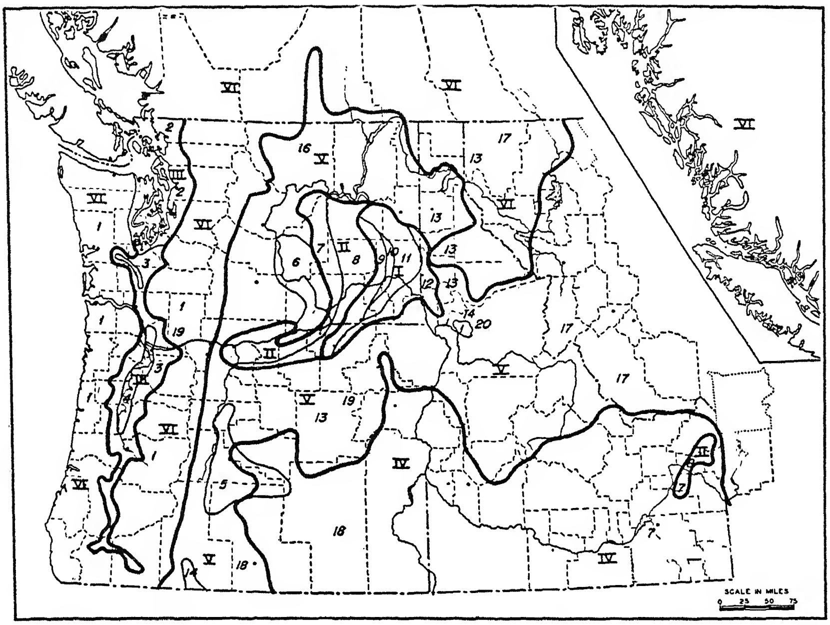

FIG. 45. Soil series and groups.
See Table 4, pages 144-145, for key to numbers.

underlying sedimentary deposits. The Aiken soils of the region are in the main developed on basic igneous rocks, mainly basaltic, under timber cover and under moderately high or high rainfall, 40 to 90 inches annually.

The surface soil of the Aiken clay loam, zero to 10 inches, consists of red to brownish-red clay loam containing a quantity of rounded iron concretions or shot. The soil has a granular friable structure and, despite its fine colloidal texture, is not difficult to cultivate. The soil contains only a moderate amount of organic matter, is sticky when wet, and is acid in reaction. The subsoil is a clay loam or clay, quite compact, but not impervious, usually bright red or slightly yellowish-red.

The surface is rolling to steep. Where topography is favorable for cultivation, the Aiken series ranks at the top of the hill soils for the production of adapted crops, such as prunes, walnuts, cherries, and field crops The addition of organic manures and lime has proved beneficial. Although this soil is not particularly erodible, serious soil losses have occurred on all clean-cultivated fields.

Olympic Series. The Olympic soils have darker surface layer, more yellow in the subsoil, and are slightly less productive than the Aiken In other respects they closely resemble that series Contrary to the general opinion, serious erosion does occur on clean-cultivated fields However, under well-planned management, erosion can be controlled much more easily than on the associated Melbourne group It is generally understood that if best results are to be obtained from these soils the organic content must be maintained or increased This group, like the Aiken, was once covered with forest, in which the Douglas fir was dominant, much of it is still covered with timber or is cut-over or burned-over forest land

Melbourne Series The Melbourne series is derived from consolidated sediments (gray to grayish-brown shales and fine-grained grayish-brown sandstones), the principal rocks of the lower hills of the Coast ranges. The Melbourne soils are characterized by the brown or slightly reddish-brown surface horizons of generally friable structure. The subsoil below 10 inches is a moderately compact yellow to brownish-yellow clay or clay loam, mottled with yellow rusty-brown and red iron stains, grading into a bed of disintegrating shale or partially weathered sandstone at depths varying from 24 inches to 4 feet The topography is sloping to hilly and in places steep and rough The surface drainage is good to excessive, but subdrainage is somewhat retarded by the compact subsoil The native cover is mainly Douglas fir and western red cedar.

The main types of the Melbourne series are generally rated as marginal for cultivation. Serious erosion has occurred on this group of soils under common agricultural practices, and continued use of Melbourne soils requires strict conservation practices.

The *Willamette* terrace alluvial and the *Chehalis* recent alluvium are the dominant water-lain soils of the area. They are level to gently rolling, have friable, slightly developed profiles, and are well suited to intensive agriculture. These soils are only slightly susceptible to erosion.

The upland soils of the northern or glaciated part of the area have been developed largely from glacial material under heavy forest conditions (Douglas fir, western hemlock, western red cedar, Sitka spruce,

and dense understory of brush). A reconnaissance survey by the Bureau of Chemistry and Soils classifies the soils of a large part of the area in one broad inclusive group, the Everett series.

Everett Series. The slightly podzolic soils of this series occupy the rolling uplands. Their surface soils are light brown to reddish-brown in color and medium light textured. The subsoil consists of gray to light brown material, lighter in color and texture than the surface. Since a much higher proportion of coarse gravel and cobblestones is found in the subsoil than in the topsoil, the soil is porous and excessively drained.

The topography is gently rolling to steep, rainfall is 25 to 60 inches annually. Native cover consists of coniferous forest of fir, hemlock, and cedar. The crop adaptation and crop yield on the glacial upland are limited and in general confined to crops of short season requirements because of (1) their drouthy nature and (2) their low rainfall during the summer season.

Erosion is only slight to moderate under clean cultivation and denuded forest conditions. Gullying is evident in some localities. Under the natural conditions of rainfall with favorable growing conditions during all but the summer months, however, heavy vegetative cover soon reoccupies the land, reducing erosion losses to the minimum.

Intermountain Basin and Plateau Grassland Area

The soils of this primarily grazing area were in the main developed under arid to semiarid rainfall conditions and with grass, sage, and scattered juniper vegetation. Because of low rainfall, 5 to 10 inches annually, shallow profile, or other inherent characteristics, they are not suited to cultivation. They constitute the extensive grazing lands of the Pacific Northwest.

The drier and shallow areas of Wheeler, Burke, Portneuf, and other soils described in area II of Table 4 are the most productive and have the most favorable soil conditions of this group for grass production. The Great Basin section in southern Oregon is characterized by extensive areas of soils derived from eruptive rock. Pumice sand, loamy sand, and sandy loams predominate, with coarser pumice subsoil resting on basic and acidic lavas. This soil group has been tentatively called Deschutes series. The internal drainage is rapid, topography nearly level to steeply rolling, lava outcrop and beds are prominent surface features in this section, and also in the Snake River Basin. Extensive overuse and attempts at cultivation have produced a sorry condition in the area, with large areas having depleted cover and showing serious wind and water erosion.

Gem and Waha Series. The Gem and Waha series of this general area comprise dark-colored soils developed over basalt under grass cover and under rainfall of less than fifteen inches The Gem series is of slightly lighter color and higher lime content and is distinguished from the Waha by these characters The Gem clay loam, extensive member of this group, has a dark brown or dark grayish-brown granular clay loam surface layer high in organic matter, and a medium brown, of slight yellowish tinge, compact calcareous clay subsoil which grades into a yellowish-brown granular calcareous clay loam extending to a depth of four feet or more. The topography is gently sloping to steep Bunchgrass and sage form the native cover The soils of this series and the less calcareous Waha are seriously eroded and require very careful management if production is to be maintained near climax level

Brownlee Series The Brownlee series is one of the residual soils developed from granite under low rainfall and grassland cover The surface of the loam type is a dark brown friable platy loam high in organic matter, this surface may or may not be influenced by loessial material The subsoil below 12 inches is a light brown or pale reddish-brown noncalcareous gritty loam somewhat more compact and slightly heavier in texture than the surface soil It has cloddy structure and is underlain by disintegrated granitic bedrock at shallow depths The topography of the Brownlee loam is undulating to steeply hilly and, despite its mellow surface and loose subsoil erosion, has reduced the carrying capacity and the natural resistance to deterioration

Extensive bodies of ancient lake and river terrace soils occur within this area. Considerable acreage of grazing land of this type has been, or is being, placed under irrigation These soils as a group do not have well-developed profiles. Sagemoor, Quincy, Ephrata, and Bannock are extensively mapped series. The Sagemoor soils consist of light brown to grayish-brown surface material overlying grayish-brown to gray subsoils which grade into a stratified deposit of gray silt loam many feet in depth The soils are of medium texture and in general there is little difference in surface and subsoil Water-worn granite boulders and other rocks rafted in by floating ice occur on the surface in places

Ephrata Series Many of the types in the Ephrata series are essentially gravelly or stony surfaced, with gravelly substratum, but others have fine-textured surface and subsoil resting on a substratum of gravels Overgrazing is almost universal, and serious wind erosion has destroyed large acreages The resulting moving dunes are a menace to adjoining areas.

Mountain Forest—Grazing Area

The soils of this area are developed under slightly more rainfall than the soils of the preceding group and are influenced by open forest cover with understory of shrubs and grasses The Underwood, derived from basalt, and the Moscow, of crystalline rock parent material, are representative of the more mature soils The steeper and more broken areas are characterized by lithosols, a group of soils that because of their youth or condition of parent material or relief have no clearly expressed soil morphology and consist of a considerable amount of freshly or imperfectly weathered rock material

Extensive areas on less rugged topography have young soils of only slightly developed profile, and because of their relatively low values have not been covered by detailed soil surveys

The Mountain Forest-Grazing Area and associated soils occupy a large area of thinly timbered east slope of the Cascade Mountains and northern Washington ranges, central Idaho, central Oregon, and the Rocky Mountains in western Montana. The climate is subhumid, rainfall is 20 to 40 inches, elevation is 1,000 to 8,000 feet Pine, sagebrush, and bunchgrass form the dominant vegetation, and grazing and forest constitute the principal use.

Mountain Forest Area

Lithosols and Shallow Soils The Mountain Forest area has predominantly shallow and stony soils consisting to a considerable extent of freshly disintegrated material differing from place to place according to the character of the underlying rock. The rocks are ancient sediments, metamorphics, granitics, and basalts Soils with the characteristics of the Olympic, Underwood, Aiken, Melbourne series occur on the lower slopes Soil studies have not been made in the mountainous areas; however, extensive areas of fine-textured soils are known to occur on steep slopes

The climate of this area is humid, rainfall ranging from 30 to 200 inches Elevation ranges from 1,000 to 14,000. The cover is dense forest.

Severe erosion, due to denudation resulting from forest fires, overuse, and careless and destructive logging operations in this area, and slight to severe erosion on other lands, resulting from man and animal activity, is constantly changing the physical constitution of the soil, including the texture, structure, porosity, consistence, and color of the various soil horizons, their thickness, and their arrangement in the soil profile. Such changes in soil morphology are already reducing the productivity of the lands of the Pacific Northwest and emphasizing the

need of planning for permanent use and for high production of adapted crops.

The Pacific Northwest, from a soil-study standpoint, is a little soil world of its own. The great range in climate, natural vegetation, and parent material supplies all the dynamic factors that produce members of most of the great soil groups A taxonomic classification, including many of the key soils of the region, is found on pages 144-145, and a map of their distribution in Fig 45, page 138

TABLE 4

TAXONOMIC CLASSIFICATION, KEY SOILS OF THE PACIFIC NORTHWEST

Order	Suborder		Great Soil Groups	Family	Series	Type	Occurrence Pacific Northwest (soil area)	Typical Series and Group Location on Map
Zonal soils	Pedocals	Light-colored soils of arid section	Sierozem soils	Portneuf	Portneuf	Portneuf silt loam	II, IV	7
				Wheeler	Wheeler	Wheeler loam	II, IV, V	7
				Sagemoor	Sagemoor	Sagemoor silt loam	II	6
			Brown soils	Ritzville	Ritzville	Ritzville loam	II	8
		Dark-colored soils of the semi-arid, subhumid grasslands	Prairie soils	Nez Perce	Nez Perce	Nez Perce silt loam	I	20
			Chestnut soils	Walla Walla	Walla Walla	Walla Walla silt loam	I	9
				Athena	Athena	Athena silt loam	I	10
			Chernozem	Palouse	Palouse	Palouse silt loam	I	11
	Pedalfers	Soils of the forest grassland transition	Degraded Chernozem soils	Thatuna	Thatuna	Thatuna silt loam	I	12
		Light-colored podzolized soils of the timbered region	Gray-brown Podzolic soils	Everett	Everett	Everett loam	III, VI	2
				Alderwood	Alderwood	Alderwood silt loam	III	
			Brown Podzolic soils	Olympic	Olympic	Olympic clay loam	III, VI	1
				Melbourne	Melbourne	Melbourne clay loam	III	1
			Gray-brown Podzolic soils	Helmer	Helmer	Helmer silt loam	I, V, VI	13
				Santa	Santa	Santa silt loam	I, V, IV	
		Soils of lateritic material	Red Podzolic soils	Aiken	Aiken	Aiken clay loam	III, VI	3

Intrazonal soils	Halomorphic saline and alkali soils of imperfectly drained arid regions	Solonetz soils	.	Not correlated	..	IV	18
		Solonchak or Saline soils			..	IV	18
	Hydromorphic soils of marshes, swamps, seep areas, and flats	Bog soils	Peat and muck	Peat and muck	.	V, VI, III	14
		Planosol soils		Not correlated	..	V	15
	Calomorphic	Rendzina soils		Not correlated	.	V	16
Azonal		Lithosols	Underwood Rough stony complexes	Underwood Rough stony complexes	Underwood stony loam	VI, V	17
		Alluvial soils	Yakima	Yakima	Yakima loam	IV, V	6

Figure 45 on page 138 is a map showing location of soil series and groups and should be studied in connection with the above table.

CHAPTER 6

THE NATURAL GRASSLANDS OF THE NORTHWEST; THEIR IMPORTANCE AND MANAGEMENT

By A. L. Hafenrichter

Extent of Grasslands

The major areas of natural grasslands of the Pacific Northwest are found east of the Cascade Mountains. Nearly all the untimbered land in eastern Washington, eastern Oregon, southern Idaho, and western Montana once was a vast expanse of bunchgrass prairie

In the original condition more than 90,000,000 acres, or 140,000 square miles, of grassland covered this part of the Northwest. The extent and location of the original prairie are shown in Fig. 83. Waving seas of grass, often stirrup-high to a horse, greeted the early explorers.[1] A typical view of this bunchgrass prairie is shown in Fig. 46*A*.

In some places, particularly in southern Idaho, and in portions of eastern Oregon and eastern Washington, sagebrush was scattered in the grassland. Grasslands merged rather abruptly into the forest at higher elevations, but throughout the timbered area they retained their identity at lower elevations, being present along the major drainageways in the Blue Mountains of Oregon and the Rocky Mountains of southern Idaho, western Montana, and northeastern Washington. The transition zone of separation between forest and grassland is short and characteristically represented in the browse-shrub and ponderosa pine types.

Importance of Grasslands

The Northwest grasslands support a large and important range livestock industry. They are the principal lands which have been converted to farming enterprises, and they afford protection to the watershed of the Columbia River and its tributaries. Interspersed as they now are with cropland where feed is produced, and adjacent to forest

[1] J. C. Fremont, Report of the Exploring expedition to the Rocky Mountains in the year 1842, and to Oregon and northern California in the years 1843 to 1844, *Document 166*, Blair and Rives, Washington, 1845

lands that are grazed during the summer months, the grasslands constitute an essential economic link in Northwest agriculture.

The grasslands found by the early explorers in the Pacific Northwest did not support great herds of wild grazing animals such as the buffalo found in the Great Plains, although some antelope were found in

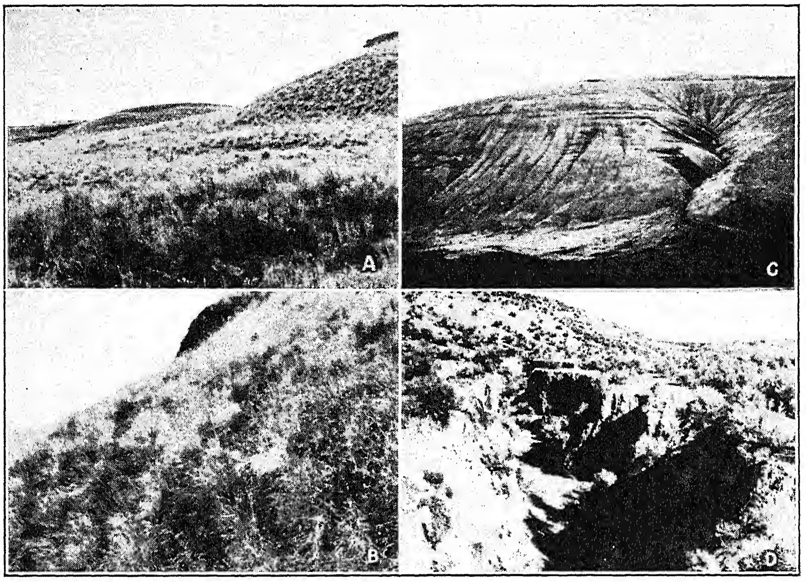

FIG. 46. Typical views of the grasslands of the Pacific Northwest showing (*A*) a general view of range land in good condition, (*B*) the density, ground cover, and feed produced by the perennial grasses of the climax vegetation, (*C*) typical overgrazed and improperly managed range land that is severely eroded and now contains only low-value cheatgrass (*Bromus tectorum*), and (*D*) badly depleted, severely eroded and gullied range land with only a sagebrush cover interspersed with poor annual grass.

southern Oregon and wild horses were reported in eastern Washington.

Livestock was first introduced into the interior from posts and forts in western Washington and Oregon about 1825, and about ten years later cattle, sheep, oxen, and horses began arriving with settlers who came across the plains. The livestock population grew rapidly. In 1850 there were only 42,000 cattle and 15,000 sheep in Washington, Oregon, and Idaho. By 1900 these numbers had increased to 1,177,000 cattle and 4,483,000 sheep. The number of sheep continued to increase for the next ten years whereas the number of cattle increased but slightly.

Exact data for the numbers of beef cattle and sheep on range lands are difficult to obtain, but it is estimated that in 1930 the grasslands of the Northwest supported slightly more than 750,000 beef cattle, exclusive of young stock, and nearly 4,000,000 sheep, exclusive of lambs.[2] In eastern Oregon and Washington about 75 per cent of all sheep are range flocks, in Idaho about 65 per cent are range flocks Both classes of livestock obtain much of their feed in the late fall and early spring from the grasslands About 50 per cent of the cattle and 75 per cent of the lambs are marketed grass-fat or as feeders from the range; the remainder are marketed after being fattened on fall pastures and winter feed lots. These figures indicate the importance of Northwest grasslands which, in addition to their value for grazing, are intimately related to agricultural lands where winter feeds are produced and to the forest lands that supply the summer range from about May 1 to October 1 or later

Large portions of the bunchgrass prairie of the Northwest were converted to croplands. The prairies were first plowed for wheat production about 1870, and by the turn of the century about 12,000,000 acres in the semihumid areas had been converted to this use During the First World War additional thousands of acres in the more arid areas were converted to wheat production. Under the impetus of high wheat prices, and high yield from new land, this proved successful. When prices returned to normal and wind erosion occurred, however, it was no longer economical or feasible to farm these marginal lands, and they were abandoned.

Late in the nineteenth century irrigation development began, and a total of about 5,000,000 additional acres of grassland was converted to irrigation farming. The present croplands are shown in Fig 96 By comparing their extent and location with that of the original grasslands, as shown in Fig. 83, it will be seen that the croplands were largely derived from the latter It is estimated that nearly one million additional acres in central Washington that are now rangeland may be converted to other agricultural use when the water facilities being developed for irrigation are completed

The grasslands of the Northwest have an important role in watershed protection They provide the essential vegetation cover for 40 to

[2] A E Orr *et al*, "Trends and Desirable Adjustments in Washington Agriculture," *Washington Agricultural Experiment Station Bulletin* 335, 1936

H A Vogel and N W Johnson, "Types of Farming in Idaho," *Idaho Agricultural Experiment Station Bulletin* 207, 1934

H D Scudder and E B Hurd, "Graphic Summary of Agriculture and Land Use in Oregon," *Oregon Agricultural Experiment Station Circular* 114, 1935

50 million acres of watershed of the Columbia River system On this river system are some of the largest storage reservoirs and power developments of the West Many smaller reservoirs and diversion irrigation works are located on tributary streams Numerous facilities to provide stock water and irrigation for hay meadows are located on individual ranches All these developments are a recognized integral part of western agriculture and represent a large investment of private and public funds.

Reduction of storage capacity of reservoirs by siltation or by damage to irrigation or power developments by floods reflects itself in individual, community, and public welfare Frequent floods affecting large areas, property, and human life are not widespread because the grasslands are most commonly located in areas with low precipitation, but localized torrential rains occur and damaging floods are reported from small grassland watersheds in the vicinity of Boise and Pocatello, Idaho, in the northern part of eastern Oregon, and in eastern Washington. Damage by siltation or floods occurs only on grassland watersheds where the vegetal cover is depleted or has been destroyed.

Ecology of Grasslands

The grasslands of the Northwest are known as the Palouse prairie climax.[3] This climax[4] is part of the great grassland formation of western North America that supports the vast range industry of the United States west of the 100th meridian. The Palouse prairie is characterized by being composed chiefly of perennial bunchgrasses The sod-forming grasses of the Great Plains are absent except in the transition zone in western Montana and in a narrow transition area in southeastern Idaho This prairie is a climax vegetation which has developed in relatively recent times The chief factors that have caused it to be differentiated from other plant associations in the grassland formation are rainless summers and cool growing seasons during spring and fall while moisture is available The plants are usually dormant during the dry summers and cold winters.

[3] F E Clements *et al*, "Ecology," *Carnegie Institution of Washington Yearbook*, Vol 38, pp 131-140, 1939

[4] The climax is a concept denoting a mature vegetation with a floristic composition and ecological structure developed through succession and capable of maintaining both its composition and structure indefinitely unless a major change in climate occurs It is a stabilized association of plants that is inherently capable of perpetuating itself unless some natural factor or man-made process destroys the equilibrium between the plants and the environment For a discussion of ecological terms the reader is referred to J E Weaver and F E Clements, *Plant Ecology*, McGraw-Hill, New York, 1929

The dominant species that give the bunchgrass aspect to the Palouse prairie climax are blue bunch and beardless wheatgrass (*Agropyron spicatum* and *A. inerme*) and two needlegrasses (*Stipa comata* and *S. occidentalis*). Associated with wheatgrass and needlegrass are Idaho fescue (*Festuca idahoensis*), Sandberg's bluegrass (*Poa secunda*), big bluegrass (*P. ampla*) or Nevada bluegrass (*P. nevadensis*), and June grass (*Koeleria cristata*). Two native forbs[5] usually occur—yarrow (*Achillea millifolium*) and balsamroot (*Balsamorrhiza sagitata*) The most common species of the prairie are shown in Fig 47

No great expanses of the climax prairie remain, but remnants may be found throughout the original area These occur where protection from grazing or other disturbance has been provided, such as fenced rights-of-way, cemeteries, and monuments, on inaccessible or excessively steep land, or where good range management has been practiced

Several experimental enclosures have been established during the past ten years, and in a relatively short time most of them have passed through successional vegetative stages to the true climax. A characteristic of these climax remnants is the luxuriance of the vegetation and the density of the ground cover as shown in Fig 46*B* All the grasses in the climax prairie have been found to be palatable and nutritious, even the cured, dry forage known to ranchers as "standing hay" The luxuriance of the virgin prairie attracted the early explorers and was in part responsible for the rapid development of the range industry

Climatic factors caused the development of the climax bunchgrass prairie in the Northwest, and because they are unique they also affect the use and management of the grassland as range. The rangelands are too steep, rough, shallow, or too dry to cultivate, and receive only 8 to 15 inches of rainfall during the fall, winter, and spring months; no effective rainfall occurs during the summer months.

During the fall and spring when the grasses are growing actively, they are intensely grazed, but the stock is moved to the higher forest ranges during the summer when the forage on the prairie is dry and water for the stock is scarce or lacking. Summer grazing is sometimes practiced where range is interspersed with cropland Severe winters over much of the area prohibit grazing at this season and require that stock be given supplementary feed. Localized areas serve as winter range and are commonly located adjacent to breeding grounds in the river valleys under the protection afforded by the deep canyons The valleys of the lower Snake River in the vicinity of Boise and Lewis-

[5] *Forbs* are herbs other than grasses, and at certain seasons they are quite conspicuous in the prairie

ton, Idaho, of the Columbia, the Snake, and Yakima rivers in Washington, and the Owyhee River in Oregon are typical examples.

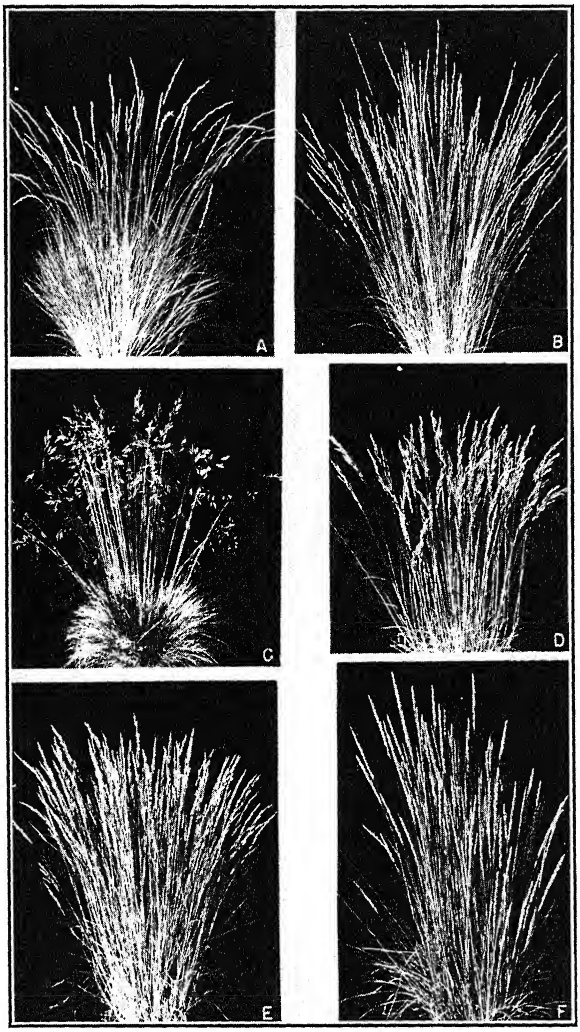

FIG. 47. The more common grasses of the Palouse prairie climax: (*A*) bluebunch wheatgrass (*Agropyron spicatum*), (*B*) beardless wheatgrass (*A. inerme*), (*C*) Idaho fescue (*Festuca idahoensis*), (*D*) Sandberg's bluegrass (*Poa secunda*), (*E*) big bluegrass (*P. ampla*), and (*F*) June grass (*Koeleria cristata*). All these grasses are valuable feeds and can be maintained under proper range management.

Climatic hazards consist chiefly of recurring years with below normal precipitation and severe winters. With an already scanty rainfall, low

rainfall years have a pronounced effect on the volume of forage produced. Such years occur, on an average, as often as 1 to 3 years in 10 and may reduce yields as much as 50 per cent They do not seem to have a pronounced effect on the composition of the prairie, although the density and vigor of the grasses are reduced often to a considerable extent and recovery in favorable years may be retarded [6] Severe winters have adverse effects on livestock unless sufficient supplementary feed is available. In the early development of the range industry such seasons caused severe losses and emphasized the need for feed production.

Changes in Grassland

The present aspect of most of the grassland area is very different from the luxuriant climax reported by the pioneers. In a classification based on the general aspect to the observer, the rangelands of the Northwest as they occur today are divided into types and subtypes of which (1) perennial grasslands, (2) sagebrush, and (3) annual grass are the most common and important, whereas (4) meadows and other types, like the browse-shrub and weed, are less important because they are limited in extent.

The perennial grassland type has the general appearance of the virgin Palouse prairie except that in many places the needlegrasses (*Stipa* spp) are inconspicuous. This type occurs in many parts of the region, being typical and most extensive where it intersperses wheatlands, approaches the timber transition zone, or is distant from water supplies It consists mostly of perennial grasses denoting good grazing practice and has a grazing capacity of 6 to 10 animal months per acre [7] This type can be seen in many parts of the Northwest along common routes of travel in eastern Oregon, eastern Washington, and western Montana In southern Idaho it is located at the higher elevations above the Snake River plains.

The sagebrush type is now extensive in southern Idaho, southeastern Oregon, and central Washington. This type has increased at the expense of the grasslands and occupies some of the abandoned cropland In its original condition it consisted of a rather sparse cover of sagebrush in a rich stand of the climax grasses and some palatable weeds

[6] J F Pechanec, G D Pickford, and George Stewart, "Effects of the 1934 Drought on Native Vegetation of the Upper Snake River Plains, Idaho," *Ecology*, Vol 18, pp 490-505, 1937

[7] Grazing capacity values of range types vary within limits depending chiefly on climatic conditions and intensity of use Values for average grazing capacity in this section are taken from several sources, but for further information the reader is referred to R E McArdle *et al*, "The Western Range III The White Man's Toll," *Senate Document* 199, pp 81-116, 1936.

Today the sagebrush is much thicker and may even appear to be dominant. It has been shown that sagebrush invades grassland range and increases with great rapidity when the grasslands are heavily and continuously grazed in the early spring while the plants are growing.[8] Continuous early spring grazing has been a common practice, and as a result the palatable perennial grasses have disappeared or are greatly reduced in density and vigor, weeds, annual grasses, and often poisonous plants have replaced them. The grazing capacity of the sagebrush type has declined more than 65 per cent, nearly 9 acres being required per animal month of grazing as compared with 3 acres or less 60 years ago.

The annual grass range obtains its aspect or general appearance from cheatgrass (*Bromus tectorum*). This introduced low-value, winter annual was rare 65 years ago, but it is now generally distributed throughout the region. It has invaded poorly managed grassland, sagebrush, and other types and occupies a large part of the abandoned cropland. Typical examples are found on the breaks of the Columbia and Snake River canyons in Oregon, Washington, and western Idaho. This type is especially persistent where range fires are frequent on overgrazed ranges. It has a grazing capacity only slightly greater than the sagebrush range and is of value only in the early spring and late fall.

The grass meadows are not extensive but are vital to the livestock industry. Interspersed with other types in the valleys of the range lands where additional moisture is available or can be provided, they supply the hay essential to wintering stock. They may consist of stands of one of the big bluegrasses and wild ryegrasses (*Elymus triticoides* or *E. canadensis*) on moist meadows as is common in eastern Oregon, saltgrass (*Distichlis spicata*) and giant ryegrass (*E. condensatus*) if the alkalinity and water table are high, or sedges mixed with grass on wet meadows. Many have been converted to cultivated hay crops and irrigated. Other types occur but are close to or within the timber types and generally not extensive because the transition zones in the northwest are quite abrupt.

Results of Changes. These changes in aspect have been accompanied by a far-reaching change in forage value. In place of palatable and nutritious perennial grasses in the once extensive grasslands, are unpalatable shrubs and weeds in the sagebrush type and less valuable species in the annual grass type. In addition, the whole plant cover is

[8] G. W. Craddock and C. L. Forsling, "The Influence of Climate and Grazing on Spring-Fall Sheep Range in Southern Idaho," *U. S. Department of Agriculture Bulletin* 600, 1938.

thinner, much soil has been lost by erosion, and water from rains and melting snow is lost as runoff instead of being absorbed These conditions are illustrated in Figs 46 *C* and *D* It is estimated that the bunchgrass ranges have been depleted to less than half their original value [9] In its original condition one square mile of the open range could supply 220 to 290 animal unit months of grazing, but at present the grazing capacity is estimated to vary from 70 to 140 animal months per square mile, depending on type The rangelands are actually being required to support nearly twice this amount of stock, hence the prospect of further decline in value is imminent.

In addition to reduced carrying capacity as a result of depletion, the value of the grasslands for the protection of watershed has also decreased. When the cover of vegetation on the grasslands is properly maintained, accelerated runoff and soil erosion do not occur, but depleted rangelands are constantly visited with these companion ills.

A study conducted on the Boise River watershed typically reveals the relation between plant cover, runoff, and soil erosion. Well-managed rangeland with bunchgrass cover absorbed an average of 99 6 per cent of the precipitation and lost only 6 pounds of soil per acre. Overgrazed rangeland in annual weeds absorbed only 39.2 per cent of the precipitation and lost 60 8 per cent as runoff with an accompanying soil loss of 15,280 pounds per acre [10] The soil lost from overgrazed ranges contributes to stream siltation, and runoff water contributes to floods and abnormal stream flow.

Siltation affects navigation and reduces reservoir capacity. A typical example is the Arrowrock reservoir. Despite heavy sluicing, this reservoir lost by siltation 7,500 acre-feet of storage capacity costing $100,000 to develop in the 12 years between 1915 and 1927.[11] The entire Boise River watershed of nearly 1,700,000 acres supports a dependent irrigation area of 355,000 acres valued at $53,000,000. About one-fourth of this watershed is overgrazed grassland on which sheet erosion is widespread and gullies are present to a serious degree

The application of this illustration to the watersheds of other reservoirs that supply irrigation water for the 5,000,000 acres of irrigated land in the Northwest is apparent. Underground water supplies also

[9] E H Clapp, "The Western Range I The Major Range Problems and Their Solution," *Senate Document* 199, pp. 1-69, 1936

[10] G W Craddock and C K Pearse, "Surface Run-Off and Erosion on Granitic Mountain Soils of Idaho as Influenced by Range Cover, Soil Disturbance, Slope, and Precipitation Intensity," *U S Department of Agriculture Circular* 482, 1938

[11] F G Renner, "Conditions Influencing Erosion on the Boise River Watershed," *U S. Department of Agriculture Technical Bulletin* 528, 1936

are reduced when accelerated runoff occurs, and loss of both water and soil from the grasslands reduces the ability of the range to produce plant cover and feed for livestock.

Cause of Changes and Methods of Improvement. The depletion of cover, the consequent reduction in grazing capacity, and the change in kind and density of vegetation in the Palouse prairie grasslands are due to improper range management. The rapid rise in number of livestock during the last half of the nineteenth century along with the free use of much of the range and lack of a plan for constructive management of the grasslands caused depletion to be recognized as early as 1900. Despite several investigations and reports and evidence that the majority of stockmen recognized depletion and overgrazing,[12] about 85 per cent of the open ranges continued to decline in value during the 30-year period from 1905 to 1935.[13]

Since 1935 several federal government service agencies and state agencies have been working with organized groups of ranchers in a co-operative effort to effectuate remedial measures. Although it will be impossible to restore much of the grassland to more than 60 to 80 per cent of its original cover and grazing capacity, it has been demonstrated that relatively simple management procedures rapidly produce desired improvement if persistently followed. The most important of these are (1) proper stocking, (2) proper seasonal use, (3) proper distribution of livestock, and (4) reseeding.[14]

Proper stocking includes adjustment of kinds and numbers of stock to the determined grazing capacity of the range. The grasslands of the Northwest are generally well suited for utilization by the two types of livestock most common in the region, cattle and sheep. Hence, after the grazing capacity of a range is determined by the range examiner who computes the kind and density of the vegetation and converts this to animal months per acre, the adjustment of numbers can be made. An essential requirement of adjusting numbers of stock to the grazing capacity is a recognition of the fact that this varies from year to year with variations in climate, particularly rainfall, and method of management. Therefore, safe stocking requires that the numbers grazed

[12] W. A. Richards, F. H. Newell and G. Pinchot, "Grazing on Public Lands," Public Lands Commission, *Senate Document* 189. U. S. *Department of Agriculture Forest Service Bulletin* 62, 1905.

[13] R. E. McArdle *et al.*, "The Western Range," *Senate Document* 199, III, pp. 81-116, 1936.

[14] For a more complete discussion of management methods the student is referred to J. T. Jardine and M. Anderson, "Range Management on the National Forests," *U. S. Department of Agriculture Bulletin* 790, 1919.

be about 25 per cent below the average forage production, or that the numbers vary with the season and the conditions of the range.

Since the Palouse prairie grasses depend chiefly on seed for their perpetuation and make most of their growth in the spring, proper seasonal use is obtained by deferred and rotation grazing. This is a particularly applicable practice in the Northwest It provides for withholding grazing from one unit of the ranch each year until the grasses mature seed, and grazing the units in rotation Stock is removed from the range in the fall, when 20 to 30 per cent of the palatable growth is still left. This method has received critical study and has been shown to be particularly applicable to Northwest ranges, where perennial bunchgrasses are the climax vegetation Such treatment coincides admirably with the growth requirement of the plants[15] Increasing the supplementary feed supply facilitates management in obtaining deferred and rotation grazing By these methods plants are strengthened and new ones established.

Hardly a range has been surveyed and studied in the Northwest where improved distribution of stock would not be beneficial. Uniform distribution is accomplished by providing salt and water at regular but different intervals on the range, the use of well-located drift fences, and proper attention to herding. Uniform distribution relieves a common situation found on ranges whereby some areas are overutilized and depleted whereas others are underutilized and the feed wasted

Reseeding severely depleted ranges may be necessary and has been successfully accomplished, but at disproportionate expense and with a high hazard of expectancy of establishing successful stands. This practice will probably apply best to abandoned wheatlands which must be reseeded if more than low-value annual grasses or weeds are obtained. The long rainless summer season coupled with the fact that Palouse prairie grasses propagate by seed has been shown to mitigate against natural revegetation on plowed and abandoned land.

Results of Proper Management

The Northwest grasslands have responded in a remarkable degree to proper range management The data from two contiguous areas on one ranch in eastern Washington are indicative of what may be accomplished in a short time.[16] One area on this ranch, when properly managed for one year, produced 2,429 pounds per acre of green feed,

[15] G W Craddock and C L. Forsling, *U S Department of Agriculture Bulletin* 600, 1938

[16] Unpublished data, Soil Conservation Service, Region 9.

16 inches tall, whereas an adjacent improperly managed, unprotected area produced only 704 pounds per acre of feed, 8 inches tall. On another ranch, one year of good management increased the grazing capacity 22 per cent and the weight of grass per acre by 32 per cent; particularly striking was the fact that the perennial grasses, wheatgrass, Idaho fescue, and Sandberg's bluegrass, increased 30, 20, and 10 per cent in density, respectively, whereas the less valuable, annual cheatgrass decreased 25 per cent. The combined increase in the density of

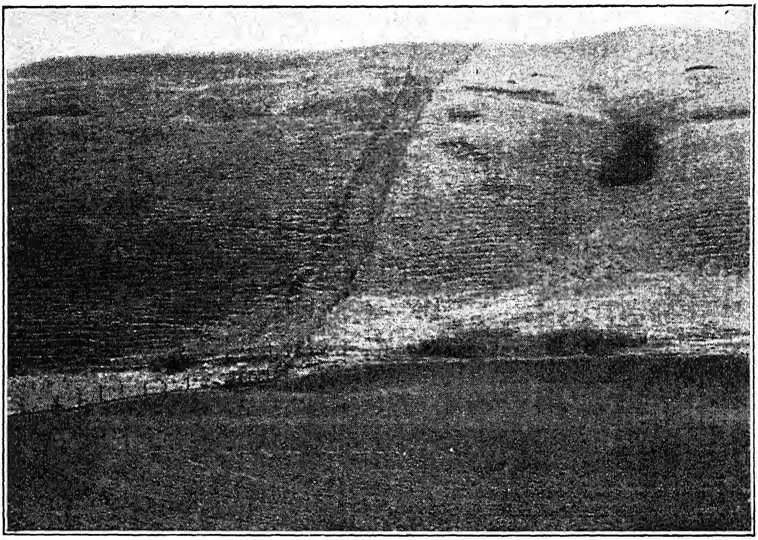

FIG. 48. Contrasting results from poor and good grassland management. *Left:* Improper range management methods result in the weakening and disappearance of valuable climax grasses, the invasion of low-value annuals, and less profitable livestock production. *Right:* Good management, consisting of proper stocking, correct distribution of stock, and rotation grazing result in maintenance of high-value climax grasses, good forage yields, and profitable livestock production.

all grasses was 15 per cent. Figure 48 illustrates the increase in density and production of grass cover and feed that was accomplished after one season of good management in contrast to that obtained where the management was improper. These values were obtained on rangeland that had previously lost 25 to 50 per cent of the topsoil by erosion and indicate the recuperative power of the climax species when proper management methods are determined and applied.

Not only do grasslands respond to expedients of good management by increase in growth and density of valuable perennial climax grasses

at the expense of low-value annuals and weeds, but it has been determined that proper management increases economy of stock production. In one experiment, cows on overgrazed range produced a 73 per cent calf crop weighing an average of 197 pounds when four months old, whereas on properly grazed range an 84 per cent calf crop weighing an average of 257 pounds was obtained.[17] Thirty per cent more feed was required for the stock on the overgrazed range, and the market value of the lighter calves was less.

By proper management of the grasslands the vicious cycle of cover depletion, accelerated runoff and erosion, and reduced income per unit is reversed to a favorable cycle of improved cover and feed, conservation of soil and water, and increased income. By proper management many of the valuable perennial grasses of the Palouse climax prairie can be restored and maintained.

It will not be possible in most cases to restore the climax to its virgin condition and maintain it under grazing use. The aim of proper management should be to attain a sustained-yield forage production which will allow a sustained-yield livestock production. Good management will prevent invasion of annual grass, undesirable weeds, and sagebrush. It will recognize that continuous heavy grazing in the early spring and late fall is damaging to the growth and perpetuation of bunchgrasses. It will recognize that range fire should be prevented and that grasslands suitable only for range purposes should not be plowed for temporary crop production.

A well-managed range that results in sustained yields will have an adequate density of perennial climax grass species to afford adequate watershed protection, and give the highest sustained economic return

[17] See also L. C. Hurtt, "Overgrazing Increases Production Costs," *American Hereford Journal*, Vol. 26 (9), pp. 58, 60-61, 1935.

M. H. Saunderson and L. Vinke, "The Economics of Range Sheep Production in Montana," *Montana Agricultural Experiment Station Bulletin* 302, 1935.

CHAPTER 7

THE PROBLEM OF SOIL AND MOISTURE CONSERVATION

By W. A Rockie

Land utilization in the Pacific Northwest, in the sense of use for agriculture, is less than 100 years old The native Indian tribes resided in the Region for many earlier centuries, but they made no particular use of the land. So far as accelerated erosion is concerned, the land in general remained in its virgin condition during the entire period of Indian occupancy, and erosion was not a problem since no factors were out of adjustment with each other

The early explorers[1] reported a vegetative luxuriance which indicated that the land and climate were favorable to agriculture Even in the driest sections of the Intermountain zone, the cover of bunchgrass was beautiful to behold This luxuriance consisted of two widely different types, the humid forest areas of the north Pacific coast and the dry grasslands and less humid forests of the Intermountain zone The humid coastal area is almost tropical in the prodigality of its plant growth Its plant density is exceeded only by a humid tropical jungle.

With the coming of the white man, land use changed. First came the cattlemen with their herds. Later, cultivation in the valleys began and soon displaced the open range Gradually, agriculture crept out of the lowlands onto the slopes and uplands It also moved from the areas of heavier precipitation onto lands of lower rainfall. A further spread occurred from the better to the poorer soils

Most of the tilled land in the Northwest has been cultivated only within the past fifty years The Willamette Valley, where farming began a little more than one hundred years ago, and the Palouse country, settled about seventy years ago, are the only extensive areas that have been farmed for a longer period Many large areas have been

[1] *A Narrative of the U S Exploring Expedition during the Years 1838, 1839-1842 (inclusive)*, Vol 4 by Chas Wilkes, Philadelphia, LCA and Blanchard, 1845

B Report of the Exploring Expedition to the Rocky Mountains in the Year 1842, and to Oregon and Northern California in the Years 1843-1844, by John C Fremont Printed by order of the Senate of the United States Washington, Gales and Seaton, 1845

cropped only from twenty-five to thirty-five years, whereas some rather extensive areas represent still younger developments.

Conservation of soil[2] in the Pacific Northwest is different from conservation in most parts of the United States. In California, in the Pied-

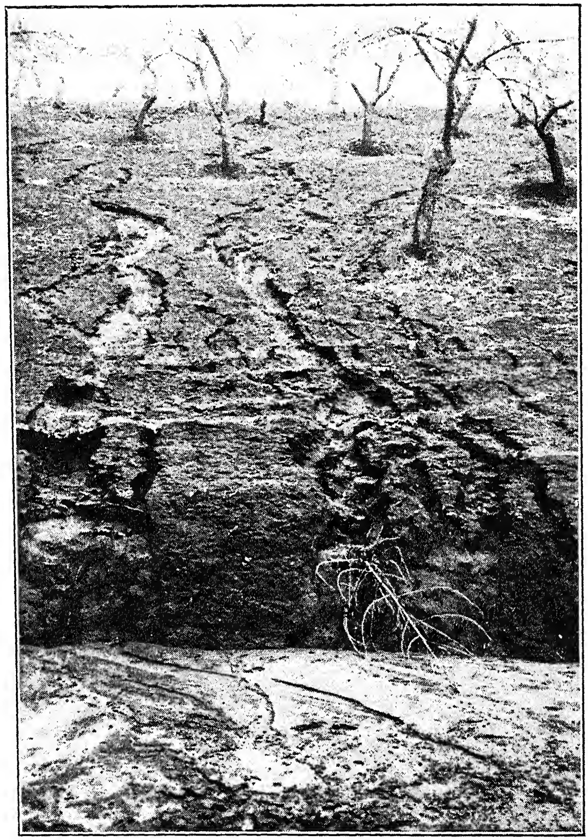

FIG. 49. Severe sheet erosion in prune orchard near Newberg, Oregon, on land valued at $400 and more per acre. (*Soil Conservation Service.*)

mont country of the eastern and southern states, in the "Dust Bowl" of the Great Plains, in the rangelands of the Southwest, and to varying degrees in other sections, it is largely a job of repairing "damaged and

[2] The conservation of soil and the conservation of water are so interlocked as to cause, methods of accomplishment, and effects that their separate consideration is usually unnecessary. In this chapter, a statement regarding soil conservation usually implies both water and soil conservation. However, this is not necessarily always true, for some phases of soil conservation may be entirely without relation to the conservation of water.

ruined land." In the Northwest the task is to forestall the occurrence of such damage. The Soil Conservation Service today is so busy working with "sick" land that insufficient thought is given to keeping the healthy land good. Because there are not enough soil conservation doctors to care for both the sick and the healthy the tendency is to let the healthy land rely on home remedies.

Early Soil Work in the Northwest

The need for conservation of the soil resources of the Pacific Northwest has undoubtedly existed on at least some of the land area since and possibly prior to its first cultivation. Some increase in soil losses probably began immediately with man's first agriculture. As in other parts of America the plowman freely tilled his land and considered his soil a permanent asset. Even the early agricultural scientists in the region did not regard erosion as an imminent problem.

Dr. E. A. Bryan came to Pullman in 1893 as the first director of the Washington Agricultural Experiment Station. He says:[3]

For the first fifteen years our attention was not drawn particularly to soil erosion—indeed, rather to the absence of it. It is to be remembered that in that period the land had not been long under cultivation. It was full of small rootlets that held soil particles as a string of beads and the soil was very like a sponge. It was a source of constant wonder to the newcomer how much moisture the ground would take up without any evidence of washing.

Most of the wheat was then spring sown and the land went through the winter with some cover which protected the soil. From 1905 to 1915 much of the winter wheat was Red Russian, a rank grower with big root system and a great clump of leaves which usually covered the ground well in the fall and quite thoroughly early in the spring. But it was clear that with the more complete pulverizing of the soil and the entire destruction of the multitude of rootlets, the tendency to wash was greater on fall-sown wheat. Especially when heavy rains and melting snows would come on thinly frozen ground a trickle of rain would cut a gutter through it. Once started it would increase rapidly. A like thing occurred with the rapid melting of deep snow drifts. Not seldom on very steep ground a slide would occur. Still the deep soil on steep northeast hillsides often took and held enormous quantities of moisture with very little washing.

In 1918, Peterson[4] said regarding the Idaho Palouse soil:

[3] Letter dated March 5, 1932.

[4] "Soil of Latah County, Idaho," by P. P. Peterson, *Bulletin* 107, pp. 13-14, Idaho Agricultural Experiment Station, May, 1918.

During the fall, winter, and spring months from 15 to 19 inches of rain falls upon the soil and is tenaciously held by it. Notwithstanding the comparatively heavy rainfall upon the hills, water seldom penetrates to the underlying rocks. The rain of this region, moreover, usually comes very gently and is absorbed as it falls. From the winter snows there sometimes occurs slight gullying as might have been observed in

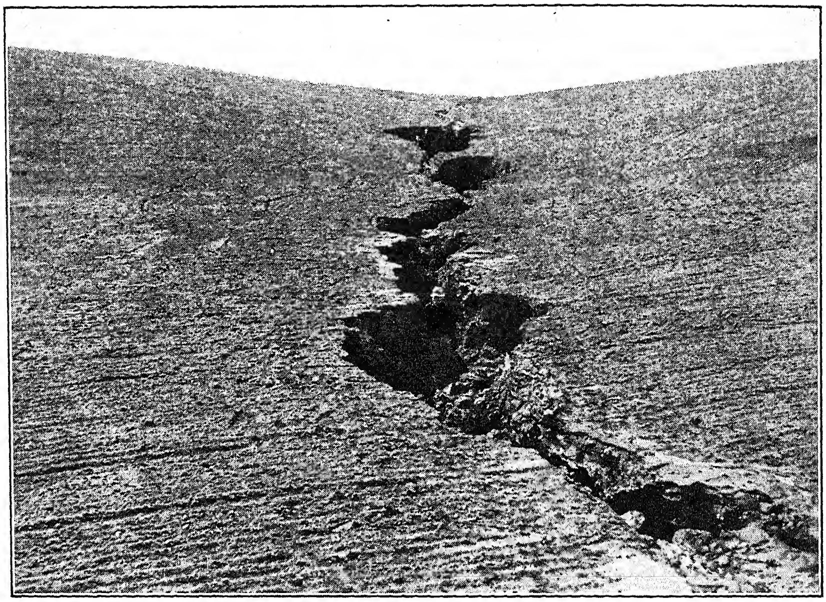

FIG. 50. Severe gully erosion in winter wheat near Athena, Oregon, in the foothills of the Blue Mountains. (*Soil Conservation Service.*)

the spring of 1916, but the summer rains, the spring rains and the fall rains never cause gullying.

As recently as 1922, Sievers and Holtz[5] in their bulletin on the Palouse soils mention the heavy loss of nitrogen by cropping and leaching, but give no recognition of any losses from erosion. Their only mention of erosion is that it is "so severe that the resulting trenches interfere very materially with field operations and with satisfactory crop developments." Their later bulletin (1924) makes no mention at all of erosion. They also conclude in this publication: "The return of straw to the soil has a depressing effect on nitrate accumulation and consequently on yield. . . . Fresh strawy manure, when applied to

[5] "The Silt Loam Soils of Eastern Washington and Their Management," by F. J. Sievers and H. F. Holtz, *Bulletin* 166, Washington Agricultural Experiment Station, January, 1922.

the soil, has practically the same depressing effect on nitrate accumulation as straw." This statement was generally interpreted by wheat-growers as official approval of stubble burning.

In none of these considerations of land problems was erosion deemed serious. In most of them it was either omitted entirely or merely mentioned in passing.

In 1930, Severance, Hunter and Eke[6] stated of the Palouse region: "Practically all of the crop land of this area has been devoted exclusively to small grain farming for 35 to 50 years. Under this treatment, the soils have lost at least 35 per cent of their organic matter, 25 per cent of their nitrogen and much of their capacity of absorbing moisture. Furthermore, soil erosion has increased during this period until it has become a serious menace." This is one of the first printed statements on the seriousness of the erosion problem in the Northwest. Even here, however, it was not recognized that erosion was a main cause of the lower organic matter, the lowered nitrate, and the lowered capacity of moisture absorption.

A series of observations since 1935 on the Charles Johnson homestead[7] sheds further light on this subject. This homestead is located in township 15 north, range 41 east, Willamette meridian in Whitman county, Washington. During the life of Mr. Johnson, his homestead remained in its virgin cover of bunchgrass. After his death in 1933 the land was sold, first cultivated in 1935, and has observed every erosion season since that date. In 1936, 1937, and 1938 no erosion was seen on summer-fallowed land seeded to winter wheat, even on 50 per cent slopes. Adjoining farms showed erosion damage on every field. In 1939, some erosion was visible and in 1940 considerable rilling occurred on 40-50 per cent slopes. These observations indicate that erosion shows plainly within the first five years after new land is broken to the plow.

The erosion problem in the Palouse region was among the first in the Northwest to be recognized, although the "blow" problems of the Big Bend area and along the Columbia River have also been known for many years. The Columbia Plateau of Oregon has an erosion problem, as have various rangelands. The seriousness of the problem

[6] "Farming Systems for Eastern Washington and Northern Idaho," by George Severance, Byron Hunter, and Paul Eke, dually published as *Bulletin* 173 of the Idaho Agricultural Experiment Station, July, 1930, and as *Bulletin* 244 of the Washington Agricultural Experiment Station.

[7] *A Monument to the Palouse Prairie,* by W. A. Rockie, Pullman, Wash., 1934, unpublished.

in the Willamette Valley escaped notice, however, until the present decade; it is now receiving detailed study.

Erosion-Control Work

Research. During the past decade, much has been learned regarding erosion conditions in the Northwest. The first step was research. The Pacific Northwest Soil Conservation Experiment Station was established at Pullman, Washington, in 1930. Besides the work at the experimental farm at Pullman, co-operative research studies have been started by this station at Lind, Washington, at Moro, Oregon, and at Moscow, Idaho. Other research projects on different phases of soil conservation have been established during more recent years at Prosser, Washington, at Corvallis and Moro, Oregon, and at Moscow and Aberdeen, Idaho.

The results of these research studies to date show conclusively that the period of profitable use under today's wheat-summer fallow system of farming is limited to a few more decades at most. They show that any one of several modified systems of wheat farming can maintain the Palouse, the plateau lands in Oregon, and other similar regions in relatively permanent agricultural use. They also show that the Willamette Valley in Oregon and the Snake River Valley in Idaho must be carefully farmed if their agriculture is to prove permanent. The growing in long-time rotation of grasses and legumes (separately and in mixtures) for hay, for pasture, for green-manuring, for seed, or for any two or more of these uses will not be less profitable than is the present agriculture At the same time, the land can be maintained, and it is possible that it can even be improved.

Demonstration Projects. To develop erosion controls on a community scale, demonstration projects were established, beginning in 1933, at many points in the Pacific Northwest. In these areas, the best and most adaptable soil-conserving farm practices were given their first general trial These projects represent a second step toward a more general acceptance and adoption of conservation farming methods

Conservation Districts. In 1939, a third step toward a fuller acceptance of conservation in farming was accomplished. The state legislatures adopted soil conservation district enabling acts, under the aid and guidance of which conservation can gradually become integrated with the prevailing land-use practices. Soil-conservation districts are locally established governmental units, and under their authority any community can control local problems on erosion or land use.

As a result there were in 1941 nine districts operating in Idaho, five in Oregon, and fourteen in Washington.

Education of the Public. The actual achievement of adequate erosion control on lands, generally, lies very largely in the future. Part of the task is education, including not only the farmers and landowners, but the mortgage holders, bankers, merchants, and citizens in general.

Part of the difficulty lies in convincing the average man that erosion is actually going on. Erosion in the Palouse, for instance, can be readily seen at certain seasons, whereas during much of the year it is effectively

FIG. 51. Gully erosion threatens to engulf farm buildings along Tatman Creek, Garfield County, Washington. (*Soil Conservation Service.*)

hidden by vegetation and tillage. Prior to the time that the Soil Conservation Experiment Station was established at Pullman, meetings were held in several adjoining communities to learn the sentiment of the farmers. At one of these meetings, a Palouse farmer spoke most emphatically against such "tomfoolery" as the study of erosion. Five years later this same farmer called at the Experiment Station office and apologized for his previously expressed views. He had moved to his present farm 28 years earlier and in the rush of the passing years had never really cleaned his farmyard. In disposing of trash and weed growth he found the seat of a mowing machine lying in the weeds. It was so solidly placed that he decided to dig it out. He found an entire mowing machine that he had discarded 27 years previously. Some 28 inches of soil had filled in his farmyard in that time.

Main Types of Northwest Erosion

Wind Erosion. With a steady rain falling at the rate of one-half inch per hour, and with a "southwester" blowing at the rate of fifty-five miles an hour, sand blows continuously on the Oregon and Washington coast beaches.

With a forty-mile southwest wind blowing over the Palouse country, a rather constant barrage of soil particles is blown from the windward to the leeward side of the Palouse hills

A fifteen- to eighteen-mile wind blowing across the dry-farmed summer fallow fields of central Washington and northern Oregon is sufficient to cause more or less continuous movement of the usually dry surface soil Even gentler winds pick up and move soils for short distances. Wherever the dry soil is left unprotected and strong winds occur, there is soil drifting. Especially strong winds cause even wet soils to drift.

Wind erosion is a potential problem throughout the entire Intermountain zone and also at certain points in the Coastal area, particularly on the ocean front and along the Columbia River. The removal of grass cover, the continuous farming to soil-depleting crops, overtillage and ill-advised tillage, the burning of grain stubble, unprotected summer fallow, grass and forest fires, and overgrazing have all helped to accelerate wind erosion in different sections of the Pacific Northwest.

Sheet Erosion. Sheet erosion is the primary stage of soil washing. The most common sign of sheet erosion is the fingerlike rills or miniature gullies which mark the sloping cultivated farm fields after heavy precipitation. This evidence of sheet erosion is usually entirely hidden by subsequent cultivation. In most years, this evidence can be found on any sloping field of winter wheat, of unplanted summer fallow, or of any other cleanly tilled or cultivated field. It is aided and abetted by several common farm practices. Up-and-down hill plowing permits faster runoff than contour cultivation. Any wheel or implement track extending downslope aids in starting a rill. Pulverization and smoothing off the soil surface also promote runoff and erosion. These rills normally run at right angles to the contour of the land.

Rills may be small but they may become large. In principle, they deepen and lengthen in much the same fashion as does a gully, except that the rills are on a more minute scale. They are generally classed as rills so long as they do not become permanent fixtures on the land After they can no longer be "plowed in" and remain permanently from one year to another, they are gullies.

Gullying. This is the sign of a more advanced erosion stage than sheet erosion Permanent gullies of all sorts generally indicate an increasingly critical condition. Gullies really ruin land quickly—and completely Even when they actually measure but a small percentage of a given field, they frequently render the entire field impracticable for use. Although gullies are found throughout the nonforested portions of the Intermountain zone, they are still few and far between when compared with more heavily gullied lands in other sections of the United States Gullies also occur locally in cut-over and burned-over forest lands, but they are almost never active in a forested area.

The soil which was carried off in rills and gullies is frequently deposited in the flats below. Too frequently, it covers the most fertile bottom lands, the farmyards, and the highways If new erosional deposits are lighter colored than the underlying material, a richer soil is being buried beneath a poorer one If the sloping lands are getting lighter in color, the subsoil is now at or near the land surface and the richer topsoil is now all or nearly all gone.

Stream Erosion. As erosion progresses, the water courses become muddy from the ever-increasing debris. The streams and reservoirs of the Northwest are becoming more and more blocked with gravel, sand, and mud bars. Irrigation waters are less clear than they once were, and silting troubles in irrigation ditches are already common. Northwest streams generally are tending toward heavier loads of soil in suspension, and consequently toward less clear water.

Results of Erosion

The actual loss of soil through erosion is direct, tangible, and measurable The Soil Conservation Experiment Station at Pullman, supplemented by field projects elsewhere in the Northwest, has measured soil losses from many available soil types under different kinds of plant cover under several different climatic conditions.

After a single heavy rain in one particular portion of the Palouse country in 1931, entire fields lost 1 to 2 inches of soil and certain acres lost more than 4 inches Generally, however, the losses during an entire year are but a fraction of the amount that is lost in such a single storm. Naturally, the soil losses are more or less directly proportionate to the amount of protection on the land In this particular storm, every principle of soil conservation was demonstrated by the condition in which different fields happened to be Alfalfa fields and grasslands showed no erosion and little or no runoff Stubble fields and grain fields had sufficient cover to prevent soil losses, but not enough to hold the water sufficiently long to permit it to soak into the ground. Good

protection means negligible soil losses; conversely, no protection means stupendous soil losses.

A similar heavy rain in portions of the Willamette Valley in June, 1936, removed nearly 2 inches of soil from many high-priced orchard lands there. This is also much more than the usual annual loss of soil from these lands. Such rains show positively that the sloping farmlands of the Northwest cannot be handled carelessly.

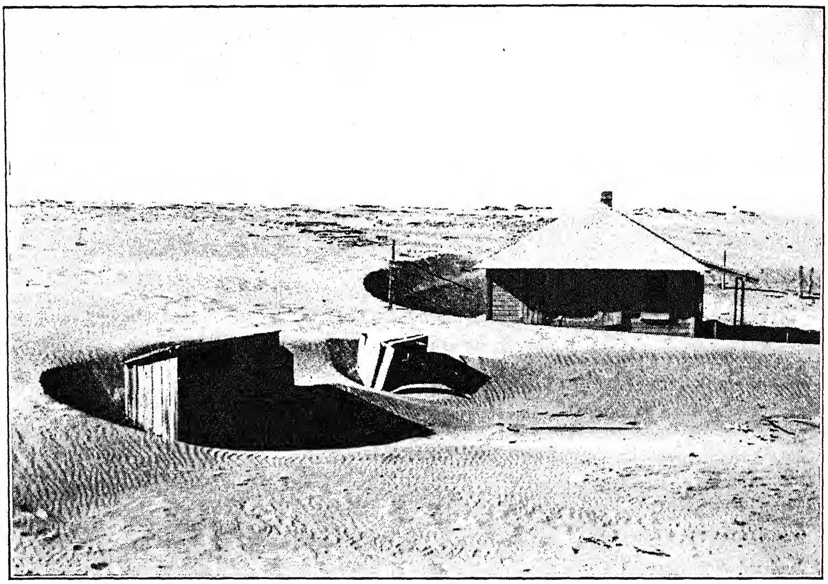

Fig. 52. Wind erosion is severe in many range and dry-farming localities. Photograph taken 15 miles south of Boardman, in eastern Oregon. (*Soil Conservation Service.*)

Orchards in the irrigated Hood River Valley show a rather startling result of erosion. On many farms the bases of the tree trunks on the upper portions of the slopes project above the ground 1 to 2 feet whereas the trees at the foot of the same slopes have the trunk base buried 2 to 4 feet. Large amounts of soil have been washed from the upper to the lower slopes during the life of the orchard. Up-and-down-hill irrigation has, in many instances, removed all the soil mantle from lands in the Northwest, sometimes within the first five years of farming.

If all soil losses in the Northwest had to be replaced by hard labor, farmlands would be valued at many times their present prices. This would be out of line with our now recognized land values. For example, the best wheatlands of the Palouse country have generally had

a selling price of $100 per acre or less. The lost soil from these lands in an average year could not be gathered from the flood-littered lowlands, loaded, hauled, unloaded, and spread to its original depth for less than $50 an acre, half of its present value

The actual soil lost in the cutting out of a gully is perhaps secondary to the other damages. Gullies are not easily crossed by machinery. By the time a gully has lengthened headward entirely across a farm, it may be of such size as to form an absolute barrier between the two portions of the farm For example, a particular farm in southeastern Washington, one-half mile from north to south and three-quarters of a mile from east to west, slopes steeply from east to west, with a difference in altitude of 800 feet Originally all of it was tilled on the north-south contour, thus requiring a minimum of farm power Nine years ago, however, in a heavy two-day rain, a gully that averages 10 feet in depth ate its way from the west to the east edge of the farm, thereby making contour cultivation possible only by farming each portion separately. A second gully has since crossed the farm so that it now consists of three narrow strips of good land extending from the valley up the steep westerly facing slope The fields can be farmed today only by tillage up and down hill. Such a farm is getting close to the abandonment stage

Another serious effect of gullying is the lowering of the water table which inevitably affects the land for varying widths along either side of the gully In the Northwest this has been sufficiently serious that hundreds of fields which yielded good crops or good pasture before a gully had become deeply entrenched are necessarily abandoned after the water table is lowered by accelerated seepage into the gully

Increased erosion also has its effect on the hydrologic cycle. Since runoff increases with erosion, the precipitation going into the ground is progressively less In time this affects spring and stream flow. Springs dry up, and streams get both lower and higher than before Floods tend to become more frequent and of greater magnitude.

Gullies and rills frequently cause considerable damage to expensive farm machinery as it jerks and bumps over the uneven surface Even heavy machinery is often unable to withstand the constant jolting over deeply eroded plowlands, and the resultant repair work has become a highly profitable business in the wheat communities of Oregon, Washington, and Idaho One Palouse farmer has estimated that his repair bill from gully and ditch breakage formerly averaged more than one dollar per acre per year He has become a convert to erosion-control practices.

The annual soil losses are already sufficiently great in the Northwest

that crop production has consistently decreased with each succeeding decade despite increases in production attributable to better varieties, better seed, better machinery, and better timing of the tillage operations. Lower production of crops immediately results in decreased farm income and ultimately in lower land values and lower living standards. Such a decline gets progressively worse as it continues, ultimately resulting in tax delinquency, bankrupt farmers, and farm abandonment, followed by both relief and migration. Such farm conditions quickly affect the towns which serve as local trading centers, and sooner or later the larger cities which service the area

Fortunately, the Northwest as a whole has had no extensive land abandonment. The land use in the region is still too young. There are a few farm areas, however, which have developed, lived, decayed, and died Typical of these ghost communities are Lake, Fort Rock, and Stauffer, southeast of Bend, Oregon. They were settled and developed between 1900 and 1910, and were mostly abandoned before 1920 One of the leading causes of this abandonment of farms, homes, and, finally, communites was soil drifting. The farmers on these lands could find no way to make the soil "stay put." It moved in every breeze, and breezes were frequent. These are probably the most impressive examples of ghost agricultural communities in the entire Northwest.

Soil Conservation on Agricultural Lands

Plant Cover for Holding Soils The character and density of the plant cover in any particular locality are jointly dependent upon the edaphic and the climatic conditions. The actual density of any natural plant cover is as heavy as the ecology of that site will permit. A plant cover tends to thin out in a drouth cycle and, conversely, to become more dense in years of heavier precipitation. An equalized and tailored plant cover normally presents adequate protection to the land on which it grows This normal plant cover proves inadequate only when abnormally severe precipitation may cause soil washing, or especially severe winds may start soil drifting.

A close examination of the land surface shows that plant cover provides many minute mechanical barriers to soil loss. Here are usually thousands and sometimes hundreds of thousands of miniature individual dams on each square foot of land, and many millions of such dams on an average plant-covered acre. Plant-covered acres show as many as 500 barriers on a single square inch of ground, or more than 3 billion little dams per acre The virgin plant cover is generally sufficiently heavy wherever the climate permits agricultural pursuits that even the exceptionally violent rain is quite ineffective as an agent of destruction

Surface Litter for Holding Soils. In some respects litter is more effective in the prevention of soil erosion than is growing vegetation. Ten years ago the progressive farmer in a community tried to keep his land so clean that hardly a straw was visible, with not a bit of vegetation in sight at the time of planting. His standing in the community rose or fell to the degree that his land was clear of, or littered with, stubble, stalks, and straw This was particularly true in the Columbia-Deschutes Plateau and the Palouse region. When a reconnaissance survey of this situation was made of the Palouse in 1931, by the writer, the burning or the burial of all plant residues was considered the most efficient and the best practice. The turning under of residues was a less desirable practice, and a few "lazy" farmers, whose fields appeared ragged and were littered with trash, were regarded as poor operators by their more energetic neighbors.

Today these same careless farmers with their littered fields are commended for having practiced, perhaps inadvertently, one of the best types of erosion control. Close study of litter on the land surface shows its astounding effectiveness in the prevention of erosion. In the absence of litter, sheet erosion of the worst degree may occur, whereas the presence of 2 or 3 pounds of broken straw and chaff spread evenly over a square rod of land (640-960 pounds per acre) may practically eliminate all soil and water losses. The amount of litter needed to provide protection varies, of course, with the character of the soil, the character of the rainfall, the slope of the land, and the uniformity of distribution of the litter. Such a mantle of litter merely provides, in altered form, the millions of little dams that are provided on plant-covered areas by living vegetation Surface litter is thus one of the most important factors which nature has attained for the complete protection of the land.

Plant Roots for Holding Soils. Soil without roots simply melts away under erosive action, but a root-filled soil is, to varying degree, a sponge. Soil filled with fine hairlike roots is practically proof against damage either by sheet erosion or by wind erosion; gullying and stream-bank erosion may move root-laden soils by the indirect method of undermining the relatively root-free subsoil

The resistance of rooty soils to erosion is dependent under any given condition upon whether the roots are still alive, or, if they have died, upon the degree of decay they have attained. The fineness of the root material and the number in a given area also affect their resistance. The plant species, insomuch as it determines the toughness of the root material, is an added factor The degree to which the roots grow and remain separate or become entangled with others materially affects their ability to hold the soil against water or wind injury. Plant roots,

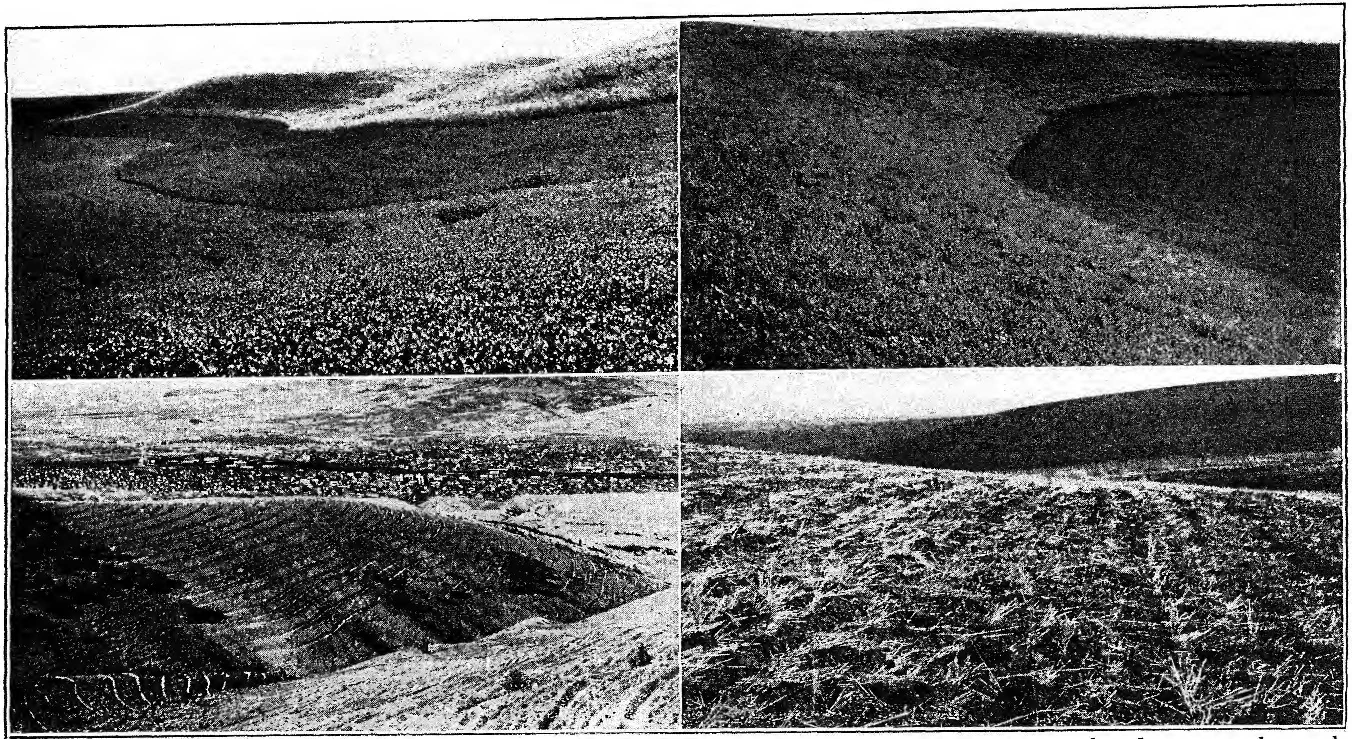

FIG. 53 (*upper left*). Strip cropping molded to fit the Palouse topography. (*This photograph by J. G. James; also photographs of Figs. 55 and 56.*)

FIG. 55 (*lower left*). Contour furrows constructed on steep, overgrazed mountain sides adjoining Pocatello, Idaho.

FIG. 54 (*upper right*). Cover crops now found on many thousands of acres of steeply sloping land in the Northwest. (*Photograph by A. L. Hafenrichter.*)

FIG. 56 (*lower right*). Trashy fallow, an extremely important practice in the prevention of soil erosion; photograph taken near Johnson, Washington.

probably as much as any other single factor, have influenced (1) the present soil structure and (2) the high organic matter content of many virgin soils.

Humus Content for Holding Soils. The humus content of a soil materially affects its resistance to erosion. Humus tends to lighten a heavy soil and tends to bind one that is sandy. It is loose and fluffy, and low in plasticity It encourages and preserves granular structure, and probably, most important of all, it greatly increases the water-holding capacity of a soil.

The effects of humus on erosion are more indirect than direct. The absorptivity and water-holding capacity of humus are probably of greater importance in this respect than any other property it has This quality is so pronounced that any addition of organic matter results in a marked decrease in surface runoff under most conditions

These fundamental principles underlying the control of erosion by means of vegetation, whether alive, dead, decayed, or returned to dust, are the basis of a large number of farming practices that now are being used successfully and satisfactorily in the Northwest.

Mechanical Barriers for Holding Soils. Ten years ago when the writer was engaged in the first full-time investigation of Northwest erosion, protective efforts against soil washing were practically nil. One farm near Waitsburg, Washington, had been rather crudely but effectively terraced by its owner and one or two farmers near Walla Walla were diverting flood waters from deepening gullies to man-made ditches having a lower gradient than the natural channel Practically no other efforts toward control of soil washing could be found in the entire Region in 1930

Probably the most spectacular early efforts to stop soil drifting were on the truck farms along the Columbia River. These truck farmers constructed fences of every conceivable sort to stop blowing soil. They planted trees, erected board fences, set poles in a solid row, built sage-brush fences, built barbed-wire fences, and draped brush between the wires, they also used wheelbarrows, wagons, trucks, tractors, and railway trains to remove the mislocated soil Old tree plantings to prevent "blow" can still be seen in numerous localities here Board, pole, and wire fences to control blow are still maintained by many farmers near The Dalles, Oregon.

Heavy fences which have failed to prevent the encroachment of drifting sand can be found buried along the beach near Gearhart, Oregon Even homes have been completely buried along the Coast

Experimental work with mechanical barriers of several different types has been carried on since 1930 Terracing with *broad-base ter-*

races[8] is considered impracticable for the rough topography of the Palouse country, but is suitable in portions of the Columbia Plateau of Oregon and in certain Coastal areas. The use of a *diversion ditch* (it is really a single broad-base terrace) is useful to intercept heavy runoff along the base of a steep slope.

Contour cultivation is the practice of farming entirely on the level Approximate contour farming has been practiced by many Palouse farmers, not for soil conservation but to make possible the tillage of lands otherwise unusable.

Oil spread, thinly coating potentially drifting sand with heavy asphaltlike oil, and *gravel spread,* using fine sorted gravel in similar manner, are successful but costly means of reducing soil blow.

Deeply entrenched, vertical-walled, arroyo-like gullies have been successfully plugged by *sausage dams,*[9] but the proper protection of these "sores" against further widening and deepening is still conjectural.

Stream-bank riprapping is often used to combat excessive stream erosion Concrete piling, concrete walls, rock walls, steel piling and wood piling, log and lumber cribbing, wire sausages, wire mats, brush, straw, loose rock, and soil have all been used in an infinite variety of combinations. The results have varied from complete success to utter failure.

All the mechanical barriers generally need so much personal attention to keep them constantly effective that they are not now, and probably will never become, as successful in the Northwest as in other sections of the United States.

Successful Soil-Saving Farm Practices—Vegetative

Cover Crops. They protect land against soil losses, improve the physical condition of the soil, and also in many other ways ameliorate the ecological conditions Both in the drylands east of the Cascades and on the wetter western slopes, grasses and legumes have become more common during the past decade.

Green-Manuring. This practice is comparatively new to most farmers in the region The turned-under crop may be legumes, grass-legume

[8] *Broad-base terrace* is simply a ditch which is either level or almost level and has a sufficiently low gradient that water can be carried therein without also ruining or damaging the lands

[9] *Sausage dam* is a woven-wire or hog-wire casing filled with loose rock, with the center of the casing lower than either end (forming a center spillway), and having the ends adequately anchored and buried in the banks of the gully

mixtures, grasses, or just grain hay. Each is beneficial in varying degree.

Strip Farming. This is the practice of laying out alternate strips of clean-tilled and erosion-preventing crops. Each strip of heavy plant cover tends to stop the erosion which starts in the adjoining clean-tilled strip Farms are strip-cropped on the contour to prevent washing, and at right angles to the wind to prevent drifting This practice is increasing slowly.

Grassed Waterways (Sodded Gullies). These simply provide a safe and harmless manner of letting runoff water reach lower levels. The draws which have for decades been cultivated, and which are being eroded into deep gullies, are used for these grassed waterways. This new practice is being widely adopted, especially in the Columbia Plateau of Oregon.

Trashy Fallow. This practice, previously mentioned, is becoming more general as farmers realize its protective value against either soil washing or soil drifting.

Riprapping Stream Banks with Vegetation Protection of under-mining stream banks has been successfully accomplished by means of vegetation when other attempts have failed Woven mats made of willow or poles, which later take root and grow, have been widely used. Planting of willow cuttings has also been successful

Successful Soil-Saving Practices on Irrigated Land

Overhead Sprinkler Irrigation This is a relatively new method of specialized irrigation which applies the necessary amounts of water slowly and evenly over the land so that runoff need not occur.

Border Irrigation or Controlled Flood Irrigation This is an open field method of flooding different units of the field by means of separating borders or ridges.

Contour Irrigation. Distribution of water on or nearly on the contour is a safe method under clean-cultivated conditions

Cover Crops. This safe method of farming irrigated land is well known in the Intermountain areas and should be used to a still greater extent.

Soil Conservation on Range and Pasture Land

Past use of the open range has, in general, been entirely without regulation Range on the national forests and occasional privately owned ranges are the outstanding exceptions In the Intermountain zone the result has been deterioration of the range, serious damage to the land by water and wind erosion, and increasing shortage of good

feed for livestock with a trend toward ultimate bankruptcy for the ranching industry. The damage is primarily resultant from overgrazing. This subject is discussed in detail in Chapter 6

The pasture lands of the Coastal area present quite a different problem from those of the open rangelands of the Intermountain zone Most of the present pasture lands on the Coast are level or nearly level alluvial flats The chief problem of these lands is chemical erosion, more commonly known as leaching The winter precipitation is so heavy that available plant food is, to a large degree, leached down beyond the reach of plants. Hence fertilization is needed for adequate pasture growth in the coastal lowlands.

A relatively small area of upland pastures, located mainly along the coast in western Oregon, has been developed on lands formerly in forest. These grass-seeded pastures present, in addition to the leaching common to all Coastal lands, a soil-washing and soil-slipping problem which will require carefully devised methods of erosion control. The eventual utilization of land in this section is still an open question. One extremist group suggests that the entire west Coastal area be remade into a pasture area (a second New Zealand), the opposing group wants the entire area left in or returned to forest.

Soil Conservation on Forest Lands

Soil conservation in the Pacific Northwest is generally a less pressing problem on forested areas than on nonforested lands. This does not mean that erosion cannot become serious on forest lands. In certain local areas it is already a problem, particularly after repeated fires, which destroy both vegetation and litter, leaving the ground bare.

Clean-cutting has been dominant in the logging history of the Northwest. This has generally transformed a veritable plant paradise into a desolate waste after logging and fire have done their work The region has a naturally high fire hazard which makes fires almost inevitable after such logging has taken place The hazard is infinitely greater after logging than in the virgin forest. The usual result, especially in the Coastal area, has been the complete destruction of all forest cover, of all ground cover (duff), burning of the brush, the death of life, and a too frequent absence even of seed trees. Grazing of forested lands has also caused an extremely localized and highly specialized type of erosion. Nearly all forested areas contain local "sores" which are actively eroding.

For the future, it is believed that better methods of logging will prevent heavy erosion such as occurs under the present system of clean-

cutting and burning. This subject is discussed in greater detail in Chapter II.

Sound Soil Policy for the Northwest

Conservation of the soil in the Pacific Northwest should mean the long-time prevention of land destruction in this part of America. Although land in certain localities (particularly the Columbia Plateau in Oregon and the Palouse) has already suffered considerable damage, erosion is just getting badly started in the Region as a whole. It can still be stopped by prompt and intelligent action.

Each Northwest citizen, whether he be farmer, merchant, doctor, clerk, or laborer, needs to realize that soils are our basic resource and must be administered and cared for as carefully as a livestock man cares for his pure-bred herd Like his livestock, his soils must be maintained both chemically and physically They must be rested and fed. When they become ill, they must be properly treated for that illness, and when they become very ill, they must be hospitalized.

The highest type of soil conservation is not merely the bandaging of "land sores," but rather the conditioning of our land so that soil erosion will not develop. It is infinitely easier and much more profitable to keep the land healthy than it is to bring sick land back to health

The future of the farmer, the landowner, the taxpayer, the banker, the merchant, the wage-earner and the salaried man, the school teacher, every boy and every girl, each man and each woman—in fact of every person resident or interested in the Pacific Northwest—hinges upon what happens to the land on which they live.

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CHAPTER 8

NORTHWEST MINERALS

By EDWIN T. HODGE

The Indians of the Northwest made weapons and domestic artifacts from obsidian, flint, lava, and other rocks or minerals but knew nothing about the extraction of minerals from their ores. After the discovery of gold in California, prospectors scattered widely throughout the western mountains and tested the stream beds for placer gold. In the decade of the 1860's were recorded discoveries of gold placers in many sections of Idaho, Oregon, Montana, northeastern Washington, and British Columbia. Soon the miners discovered the veins of gold-bearing quartz and of silver, lead, copper, and other metals, but until railroad transportation was provided the mining of quartz was generally too expensive to be profitable The building of railroads permitted the opening of base-metal mines early in the 1880's, and the Northwest has been an important producer of copper, lead, and zinc in addition to gold and silver ever since. The mining industry led to the exploration and settlement of mountain sections years before this would have happened otherwise.

Besides the prospector who learned mining in the school of experience, there is need of trained engineers and geologists to develop economical methods of mining and of metallurgists to determine the best way for the efficient extraction of metals from their ores. Numerous surveys by state and government agencies have aided the mining industry. Schools of mines and mining departments in educational institutions in the Northwest have furnished trained men and published information about mining methods and districts Mining provided freight for the railroads, aided in the construction of highways and development of hydroelectric power, furnished much of the wealth to construct our large cities, and afforded a market to the farmers for part of their crops. The mining pioneers were rugged individualists, and the industry has been carried on by such men.

The total value of metallic mineral production in the Northwest exceeded \$170,000,000 in 1940, divided as follows· British Columbia \$66,000,000, Montana \$56,000,000, Idaho \$37,650,000, Washington

$7,190,000, and Oregon $5,794,018. In addition, coal, cement, rock, phosphates, and other nonmetals were produced to a total value of many millions of dollars Since the beginning of mining, the entire output of minerals from the four northwestern states is valued at nearly $5,000,000,000, of which gold, silver, copper, lead, and zinc account for $4,300,000,000 to the end of 1940 The Butte mines have produced in excess of $2,000,000,000 in metals, and the Coeur d'Alene mining region has had an output of nearly $1,000,000,000. Although some small mining operations are carried on, the chief production is made by well-financed corporations At present the four northwestern states produce one-fourth of the lead, one-third of the silver, one-sixth of the copper, one-twentieth of the gold, one-fourth of the mercury, and one-fifteenth of the zinc produced in the United States. It is probable that numerous additional mining properties will be developed.

Origin of Mineral Deposits

Mineral deposits result from geologic processes. Hence it follows that, if the chemist, physicist, geologist, and paleontologist can determine the character of mineral deposits and how they originated, additional deposits can be located and the ore mined economically Ore deposits are formed during periods of geologic activity, when the crust of the earth is being altered by fracturing and folding, and when hot liquid rocks are cutting their way to the surface. The most important deposits are found in the older rocks near where molten rocks have cooled and solidified as intrusive granites, diorites, etc. (Fig. 57)

All mineral deposits originally were derived from igneous rocks—rocks that have formed from the cooling of a magma (or molten rock)—either at depth or near the surface. From these rocks have been derived the other two classes of rocks: sedimentary rocks, formed by the breakdown or weathering of a pre-existent rock, and metamorphic rocks, formed by the alteration, either mechanically or chemically, of a pre-existent rock. Although mineral deposits are common in the latter rocks, the constituents of ore deposits were originally associated with igneous rocks.

Mineral deposits in the Northwest, like those elsewhere, may be divided into two main groups those formed by mechanical processes of concentration under conditions of a moderate temperature and pressure; and those produced by chemical processes of concentration in which the temperature varies between wide limits according to the particular ore deposit.

The term placer is commonly applied to the mechanically made deposit formed at or near the surface. Weathering releases minerals

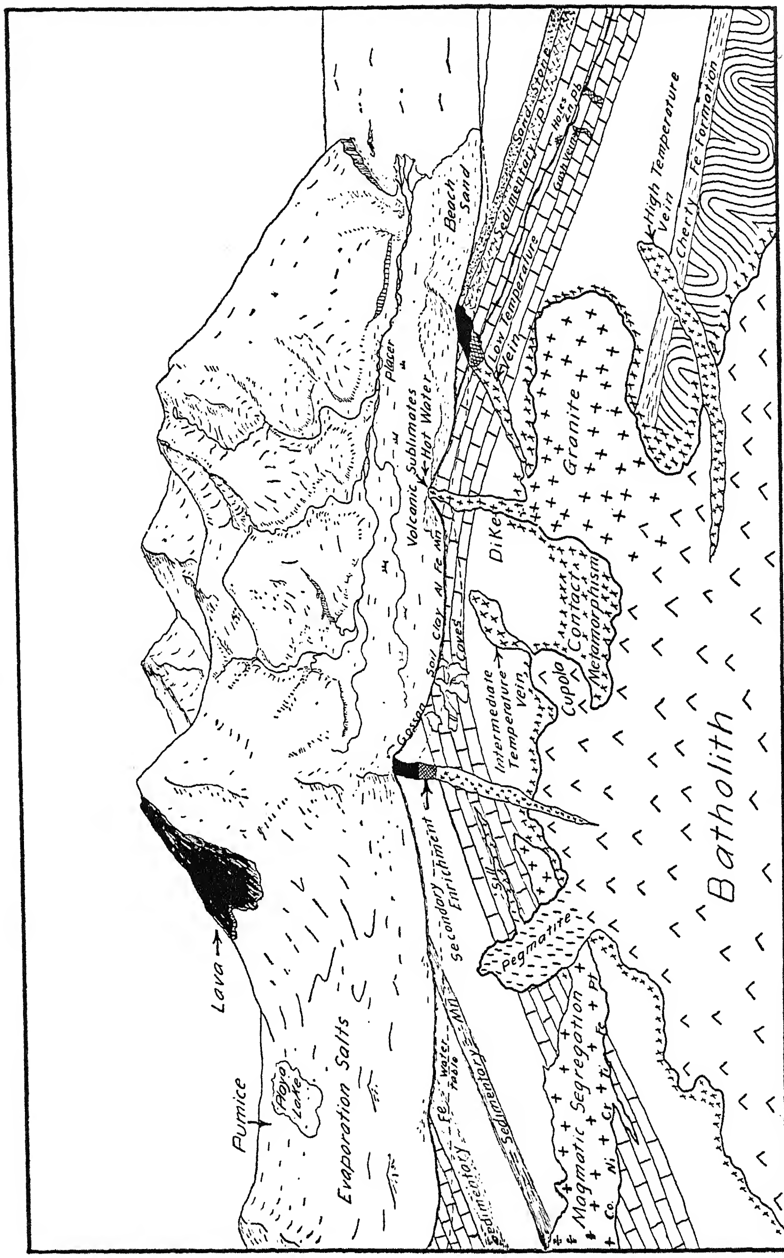

FIG. 57. Geologic occurrence of mineral deposits.

that largely resist change like gold, platinum, magnetite, and garnet, and they then may be carried away by the power of moving water. Differences in gravity allow the heavier particles like the gold to collect in the lower part of sand and gravel deposits, forming a placer. Both stream and beach placers exist in the Northwest. The stream placers are most common in streams that come from mineralized areas of crystalline rock Beach placers occur on the Pacific at the foot of the Klamath Mountains as deposits of "black sand" that contain gold, platinum, and magnetite Lighter materials are transported farthest, and certain quartz and clay deposits result therefrom

Coal is the principal mineral fuel occurring in the Northwest By its association with coarse, cross-bedded sandstones, it seems, the coal was formed from beds of vegetable matter that accumulated in deltas and flood plains. When such deposits are mostly under water, decay is prevented and, when buried under a load of sediments, the organic matter is slowly changed by heat and pressure into coal. Small deposits of natural gas have been discovered in the Northwest, but no commercial oil has yet been found west of the Great Plains or north of central California, except a small output from Alaska

Another group of deposits are those which are associated with surface water. Deposition may come from interaction of solutions by evaporation and by biochemical precipitation produced by bacteria and diatoms. Examples include deposits of carbonates and sulphates, mostly of sodium, in the beds of dried up lakes and deposits of limestone, iron, and other substances made by springs Probably the bulk of the limestone, dolomite, chert, manganese, iron, and phosphate deposits are the result of the interaction of solutions

The next group of ore deposits are formed in bodies of rock and includes the greater portion of the metallic mineral deposits in the Northwest. All rocks are more or less cracked, fractured, and broken, especially those near the surface At times major fractures, called faults, have been sites where one portion of the earth has moved in relation to another. It is along such lines or zones of weakness that chemical solutions have passed and often deposited minerals of commercial value as in the Coeur d'Alene district In this division are two classes first, those deposits formed from mineral matter of the rock itself; and, second, those deposits formed by the introduction or intrusion of foreign chemical matter into the rock by igneous activity Ore deposits typical of this first class include residual clays, residual iron ores (gossans), phosphate, bauxite, sulphur, magnesite, and numerous others.

The second class, dependent upon the introduction of foreign substances into the rock, contribute many of the Northwest's most important metallic ore bodies These are mainly vein deposits formed by hot

ascending waters charged with emanations from the eruption or activity of igneous rocks (magma) Igneous activity has occurred intermittently throughout the geologic past. As these magmas are often deep seated, veins may be formed from solutions given off by the magma either at great depths (with high temperature and pressure), moderate depths (with temperature and pressure somewhat lower), or at slight depths (with relatively low temperatures and moderate pressure). These deposits usually form in cracks, fractures, and zones of weakness, they are known as veins Also where magmas directly contact other rocks, ore deposits may be formed by alteration, replacement, or deposition of material in the invaded rock Also geyser and hot-spring deposits are grouped here. Minerals of this second group include deposits of cinnabar (mercury ore), stibnite (antimony ore), sphalerite (zinc ore), tetrahedrite (a complex sulphide of antimony and copper), gold, argentite (silver ore), gold tellurides, tungsten, numerous copper ores, arsenic, cassiterite (tin ore), wolframite (tungsten ore), magnetite, and many others. Common gangue (nonmetalliferous) minerals accompanying these ores are quartz, calcite, dolomite, fluorite, and barite.

The third and last of the conditions under which chemical concentration takes place is in magmas or molten rock, usually at great depth and under high temperature and pressure The ore deposits result from a settling of the heavy minerals in the molten mass after they crystallized out of it during the cooling of the magma. Minerals in this group are of simple composition, including magnetite, arsenopyrite, cassiterite, molybdenite, corundum, and platinum. Another group of minerals in this class results from concentration occurring in dikes given off by this magma or molten mass, assumedly due to the pressure produced by the contraction of the cooling mass. Minerals resulting from this action include commercially valuable quartz and feldspar, mica, magnetite, cassiterite, and beryl. The sulphide minerals occurring here are usually not of commercial value.

All ore deposits upon exposure to weathering, usually near the surface, break down and may be transported and redeposited in other forms The mechanically deposited minerals in placers and minerals deposited in bodies of surface waters result from such transportation and deposition.

In places the earth's crust has been folded and fractured, and tilted upward to form mountains. Later erosion of the mountains exposed the hidden veins and lodes. As a result, older mineral-bearing rock has been brought to the surface This is important in an area where lava, lake beds, and other rocks would normally cover the surface and hide whatever minerals might be below.

Ores are combinations of minerals which can be mined and sold at a profit. An ore commonly contains one or more valuable minerals, such as the above, and others which are worthless. The latter are called the "gangue" Ores occur as rare bodies in the "country rock" Some of the common gangue minerals are quartz, calcite, dolomite, siderite, and limonite.

The price of a metal depends upon its abundance and the cost of mining and extraction (smelting). Thus, six tons of iron ore which is mined with power shovels from open pits can be purchased for the price of one ounce of gold. Nonmetallic substances such as coal, salt, feldspar, or building stone are used practically in the form in which they are extracted from the earth.

Distribution and Age of Ore Deposits

The ore deposits of the Northwest are not scattered at random over the region, but instead occur in definite mineralized areas, shown in Fig 58. The favorable localities are near the contacts, mostly in the adjacent "country rocks" of the "intrusive rock batholiths" All the "Quaternary sediments," most of the "marine sediments" and "lava-capped surface," and some of the "undeformed Mesozoic" are younger than the intrusives and consequently could not have been mineralized by them The other rocks are older and under favorable conditions mineralized; the folded "pre-Cambrian" being more favorable than "complex Paleozoic and Mesozoic rocks," which in turn are more favorable than the "undeformed Mesozoic." Where the above mineralized areas have been eroded, gold placers may be found in the water-washed debris near by. The "Tertiary marine" is favorable for oil, coal, limestone, clays; the older rocks and also those of Paleozoic and Mesozoic age are possible sources of nonmetallics, particularly for phosphates The Quaternary sediments may contain lake deposits with alkaline salts The periods when mineralization took place and the age of some economically important deposits are indicated in the geological table, Table 2. It should be noted that each epoch of eruptions was followed by a more or less intensive mineralization, consisting in the development of ore minerals by the filling of fissures, or by the replacement of the rocks themselves in or about the igneous rocks.

British Columbia Minerals[1]

Mining in British Columbia was inaugurated by the discovery of placer gold on the Columbia River in 1855 and in the middle Fraser

[1] Prepared by N F G Davis, Department of Geology and Geography, University of British Columbia Specific data furnished by Dr Davis have been added to discussions of certain minerals throughout this chapter

valley two years later. Many of the gold-seekers who rushed into the country came to the mouth of the Fraser by sea and were already experienced placer miners from California. Gold has continued to be the leading mineral of British Columbia; but in more recent years there has been a steady expansion in the production of other metals, various

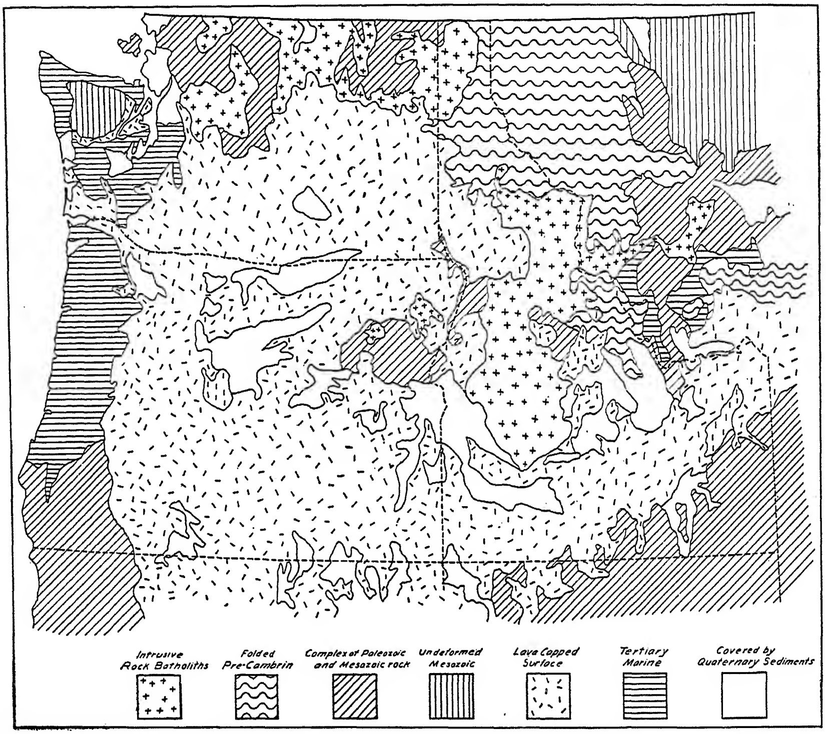

Fig. 58. Generalized geological map of Pacific Northwest.

nonmetallics, and coal. In 1940 the mining payroll of the Province exceeded 16,000 men, and the entire production was valued at over 75 million dollars, an all time record output. About 90 per cent of this production comes from south of the fifty-first parallel, in the territory included in this study of the Pacific Northwest.

Metal mining in the Province, valued at nearly 65 million dollars in 1940, can be roughly divided into placer and lode gold, silver, copper, lead, and zinc. In many places these metals occur together: Two common associations are silver-lead-zinc and copper-gold. Most of these mineral deposits are associated with intrusive rocks of Jurassic or Lower Cretaceous age. Mines are situated along the eastern and western

contacts of the Coast Range batholiths and the Selkirk and Monashee Mountains.

MINERAL DEPOSITS AND PRODUCTION

Coal

The coal of the Northwest has never received the exploitation expected owing in part to competition with imported low-cost petroleum and local water power Its qualities make it a high-grade source of raw material for the electrochemical and electrometallurgical industries.

Production in the Northwest states since the inception of coal mining totals about 119 million tons varying in grade from lignite to high-grade bituminous. At two places north of Mount Baker in Washington veins of anthracite are exposed, but being far removed from transportation no mining has occurred The estimated total coal reserves in the United States part of the Northwest amount to about 64 billion tons mostly in the state of Washington. In 1918 over 4 million tons were produced, but output has fallen. In 1938 it amounted to 1,400,000 tons. Research in utilization, both in firing and in the chemical industries, might assist in the revival of this industry

Alaska and the Northwest possess several billion tons of coal that could be mined and laid down at low cost close to hydroelectric sites. Use of this coal for chemical manufactures will require much electric energy, give vitality to many dormant and unexploited coal deposits, absorb a large amount of labor, and yield products obtainable now only at high cost to western consumers. Directly the coal can be used to make graphite, silicon carbide, calcium carbide, and many hydrocarbon derivatives

Several types of coal occur in the Northwest and adjacent areas.

a Metallurgical coking coals occur in western Washington, on Vancouver Island, British Columbia, in the Bering River and Matanuska coal fields of Alaska, all close to tidewater, and at Crow's Nest Pass, Alberta, Canada

b. Bituminous coals of good grade are found in all the above districts and in central Washington and southern Oregon

c Lignite coals are found extensively in Montana, western Washington, and near Coos Bay in southwestern Oregon

d Semianthracitic coal occurs in quantity in the Cascade Range of western Washington, especially in Lewis County

Oregon contains numerous scattered coal fields, the most important of which is the Coos Bay field in the southwestern part of the state The Coos Bay region is the only one that has recorded a steady but small production.

Washington coal is mined extensively on the Puget lowland at Bellingham, at several centers in King, Pierce, Thurston, and Lewis counties, and on the eastern side of the Cascades, in Kittitas County (Roslyn, Cle Elum, Easton), which leads the state in production

Montana has more coal, 407 billion tons, than any other state west of the Mississippi, the bulk being lignite. This is 11 5 per cent of that of the United States and 8 per cent of that of the world With few exceptions the Montana coal is located in the Great Plains, not included in this study, but furnishes fuel to western Montana and to a small extent to other parts of the Northwest Some of the Montana coal like that of Trail Creek and Great Falls can be made into coke.

Coal deposits are widely distributed throughout British Columbia with most of the production coming from three localities in the southern part. The total coal produced from the Province amounts to over 1,300,000 long tons per year valued at 5 million dollars About 3,000 workmen are employed. In the East Kootenay district, the coal is mined from beds in the Rocky Mountains. This region has extensive reserves, produces nearly 500,000 tons per year, and in the past had a much larger output. This coal is of a high-grade coking quality, the coke ovens at Michel producing 50,000 tons annually

The Coast District includes the Nicola-Princeton and Vancouver Island collieries that together employ 2,300 men. In 1938 the Nicola-Princeton collieries produced 186,972 long tons, and the Vancouver Island Collieries 684,398 long tons. The coal is of good quality and close to tidewater. Much of the Island coal is used for ships' bunkers, and 153,267 tons were used for this purpose in 1938. Exports to the United States from the Province amounted to 91,455 tons in the same year.

British Columbia has large coal deposits and considerable expansion will be possible. The reserves, however, are highly controversial. In 1912 the International Geological Congress estimated that Vancouver Island alone contained 5,793,000,000 tons. On the other hand, C M. Campbell[2] states that an excessive gas content in the coal and structural weakness of the rocks will prevent mining below a depth of 2,000 feet and quotes J D MacKenzie, who would cut the total of available coal to only 26 million tons. Probably the truth lies between these two extremes.

Petroleum and Natural Gas

No commercial deposits of petroleum have been found in the Region despite considerable exploratory work A small producing gas

[2] *Economic Geology*, pp 670-674, August, 1940

field in the Rattlesnake Hills of southern Washington supplies natural gas to near-by communities in the Yakima Valley, and some shows of gas have been found in other places in the Northwest. Outside the Region oil and gas occur in quantities on the Great Plains, and some Montana petroleum is refined at Butte and Spokane

Limestone and Building Stones

Limestone of high quality is found in northwestern and northeastern Washington, central and southern Idaho, northeastern and southwestern Oregon, throughout many parts of British Columbia, and in many western Montana counties Numerous deposits of limestone occur at tidewater on the islands off the coast of British Columbia and on the Canadian mainland Several deposits are worked around the Puget Sound and northeastern Washington, northwestern and northeastern Oregon, southern Idaho, and central Montana areas to supply cement plants and pulp mills.

The largest cement plants are located at Trident and Hanover, Montana, at Bellingham, Concrete, Grotto, and Seattle in western Washington, at Metaline Falls and near Spokane in eastern Washington, near Pocatello, and Orofino, Idaho, and at Gold Hill, Lime, and Oswego, Oregon. High-grade marble occurs near Northport, Washington, and in the Wallowa Mountains of Oregon, but neither marble nor limestone is quarried to any large extent for building purposes

Because of small demand the output of granite and other building stone is small, being restricted mainly to monumental and decorative purposes Small granite quarries are operated near Spokane Lavas and other stone are locally crushed for roads and other construction use in response to local demand

Phosphorus and Fertilizer

The Northwestern states contain 93 per cent of the *high-grade* phosphate reserves of the United States and more than half of the world's known supply There are proved resources of over 5 billion tons in Idaho and 400 million tons in Montana, whereas for the world as a whole only 10 billion tons are known

The thickest and richest deposits of phosphate are found in southeastern Idaho (as well as in adjacent parts of Wyoming and Utah) along both flanks of the Uinta Mountains They also occur at numerous places in western Montana Phosphate rock is mined commercially in southeastern Idaho and near Garrison, Montana

In Idaho the phosphate-bearing member contains shales, sandstones, and limestones in addition to beds of phosphate, with the main

bed, five feet or more thick, usually containing 70 per cent or more of tricalcium phosphate Near Garrison, Montana, phosphate rock is mined and shipped to Trail, British Columbia, and to Anaconda, Montana, where it is treated with sulphuric acid to make an acid phosphate in which form it is easily taken up by plants About 65 to 75 thousand tons are mined each year, worth about one million dollars. It is also probable that phosphates can be profitably produced by hydroelectric power, and the operation of large mines to supply phosphate plants operated by power from the upper Columbia would seem to be very probable in the future, especially as the phosphates would be convenient for deep-water shipment to world markets.

Magnesium

Huge deposits of magnesite occur near Chewelah, Washington, and so far as is known are the largest deposits on earth. The material is calcined in rotary kilns for use by steel companies in open-hearth furnace bottoms and as firebrick for various furnace linings. Deposits of dolomite (magnesium limestone) are known in northeastern Washington and may be a future source of material for magnesium manufacture. Magnesite also occurs in the East Kootenay near Marysville, B C.

Now used in small quantities in alloys for airplanes, in light railway equipment, in automobiles, and for various structural purposes, magnesium is frequently called "the metal of the future" No other metal has such light weight combined with such great strength, and a cheap method of production would open up to mankind many fields of activities now denied him

Magnesium-bearing ores yield products for many uses (a very important one is for refractories), but its greatest future use will probably be in the production of magnesium metal In 1941 a plant to manufacture magnesium from magnesite was planned to be built in eastern Washington, as part of the national defense program

The production of this metal, using Northwest water power and our great ore supply, will contribute strictly to a noncompetitive market The consumption has increased 50 per cent per year since 1922 The production of magnesium metal in the United States has been small in part because the only eastern producer has an inadequate source, the metal being obtained as a by-product from salt brines.

Aluminum and Alumina

There are no known supplies of bauxite, hydrous aluminum oxide, in the Northwest, but millions of tons of high-grade kaolin, or China clay, are known From these, alumina can be extracted, and the deposits

deserve careful attention to determine if the extraction of the metal from this compound by electric energy can be carried on profitably. The recovery of aluminum from bauxite requires cheap and abundant electric power Attracted by this, a plant to manufacture aluminum from processed material made from imported bauxite was constructed in 1940 at Vancouver, Washington, where ocean boats can dock and power be bought from Bonneville Dam. The plant will supply aluminum to the West Coast airplane industry and for other purposes.

Another plant at Longview was under construction in 1941, and three more plants were projected in other parts of the Northwest. A certain type of igneous rock called alunite, of which there are deposits in Utah, Idaho, and near Enumclaw, Washington, is being considered as a logical source of aluminum ore for these new plants.

Clay and Kaolin

Good clay deposits are scattered over all the Northwestern states and in British Columbia, especially at Kilgard in the lower Fraser Valley. Numerous deposits of good brick or pottery clay and shale are known, and several plants, usually near the larger cities like Seattle, have been erected to supply local demand Willamina on the west side of the Willamette Valley is the largest plant in Oregon Clayton, north of Spokane, has the largest plant east of the Cascades Large quantities of common clay are also dug and burnt for drain, common brick, and similar uses in many counties The total value of clay products in the Northwest is over 15 million dollars.

Heretofore, much of the high-grade kaolins have been imported from England for paper fillers and ceramic manufacture. Deposits of clay, estimated at 100 million tons, are located in eastern Washington and in Latah County, Idaho These clays are of pottery and paper-filler grade, but only building materials are manufactured from them at present The local kaolins are also equal in quality to any other domestic or foreign kaolins. The problem of separating the desired raw materials from impurities has been solved, and from the kaolin high-grade chinaware has been made experimentally. Since both ceramics and refractories are rapidly moving toward electric production methods, the Northwest apparently has two of the bases—raw material and power—for an important ceramics industry.

Silicon

There are many deposits of silica, mostly beds of quartzite, occurring in the old pre-Cambrian rocks of northern Montana and Idaho, of which only a few have been investigated. Deposits of high-grade silica

rock exist in eastern and northwestern Washington and in various parts of central Idaho, but no systematic attempt has ever been made to ascertain the best silica supplies available throughout the Northwest.

China clay deposits often contain silica and mica and could furnish, as by-products, silica sands, glass, silicon carbide, ferrosilicon for high-grade alloy steels, and much fine, white mica for molded electrical insulation and other filler purposes A western glass industry would require alumina for glass refractories and silica for glass mixes, which can be obtained from these China clays.

Iron and Steel

The market for iron and steel material of the type suitable for comparatively small iron fabricating plants and not including ferro-alloys, now supplied by importations, is in excess of one million tons a year in the Northwest. Large supplies of iron ore apparently adapted to electric smelting are available in the Region.

Charcoal iron was produced close to Portland from 1865 to 1895, but because of competition from large eastern plants and the low freight rates for pig iron, on vessels from Europe, the operation finally ceased. At Irondale, Washington, pig iron was produced intermittently from 1880 until 1911 Also a plant at Kirkland, Washington, successfully produced pig iron in 1891.

Extensive limonite (hydrous iron oxide) beds with some hematite (iron oxide) occur in Columbia County, Oregon, close to Bonneville Dam; scattered ore bodies of magnetite (another iron oxide), hematite, and limonite occur in northern and west-central Idaho, hematite occurs in the Little Belt Mountains of central Montana. In British Columbia iron ores are found on Vancouver Island, Texada Island, and along the coast of the mainland. Although the deposits are somewhat dispersed geographically, it is known that the total available amount of iron ores will support an iron industry of considerable size. Importable tidewater iron ores of high content occur on the islands off the coast of British Columbia and at several coastal points in Alaska. In Washington, magnetite is found at Snoqualmie Pass, King County, in connection with metamorphosed limestone, and on Skagit River in the northern Cascades. In the Squaw Creek district, Okanogan County, a ledge of magnetite ore several feet thick is exposed for a length of 400 to 500 feet. Limonite and other iron ores have been found at several places in Stevens County, Washington.

An iron and steel plant has been constructed at Vancouver, Washington, intended to use local iron ore and scrap iron as its raw material A steel plant at Seattle uses scrap iron and imported pig iron mainly for

its source of iron, and several smaller fabricating works are located in various parts of the Northwest.

Ferroalloys

This is an age of alloy steels given special qualities by the addition of one or more other metals. These steels can be made in the electric furnace from raw materials either available in the Northwest or from convenient foreign sources. The main ferroalloy metals are chromium, manganese, molybdenum, tungsten, silicon, titanium, vanadium, nickel, and cobalt.

Several of them occur in commercial quantity in the Northwest, and are at least possibilities for the future development of a local alloy steel industry.

Chromium. Chromium comes from the mineral chromite and is a war metal necessary for stainless and noncorrosive steels which will withstand high temperatures. Deposits of chromite, scattered throughout the Northwest and Alaska, were mined to a small extent during the World War. In Oregon the ore occurs in Wheeler, Grant, and Baker counties, from which about 13,000 tons came annually in the latter years of the war. Chromite has also been found in the Klamath Mountains, in the Beartooth Mountains of Montana, and in Kittitas County, Washington. A large deposit on the Kenai Peninsula, Alaska, is being developed preparatory to production.

Manganese Manganese oxide ores have been mined in Montana, and smaller deposits occur in Idaho, Washington, and southern Oregon. The most likely indication of a possible supply of manganese is in the Olympic Mountains of Washington, where a belt that encircles the mountains contains at intervals manganiferous ore bodies ranging in thickness from a foot or less to 20 or 30 feet. In Oregon deposits derived from manganous chert beds are associated with lava flows in the southwestern part of the state. A bed of manganese oxides located about a mile southeast of Cleveland, Idaho, has been mined intermittently. From 1924 to 1928 it yielded about 5,200 tons, which averaged about 42 per cent manganese.

Extensive deposits of manganese carbonate occur in western Montana near Butte and Phillipsburg, where it was first produced in 1916 The annual production exceeds that of all the other states combined. The mines at Phillipsburg are usually the chief domestic source with an output of about 10,000 tons per year, the high quality of the ore permitting it to compete with cheap foreign sources. The total production to 1940 exceeds 20 million dollars Demands for national defense raised prices for manganese and stimulated production in 1940 The

Anaconda Copper Mining Company at Butte contracted in 1941 to supply for the government 240,000 tons of manganese iron over a three-year term at the rate of 80,000 tons per year. Production at Phillipsburg is also being increased.

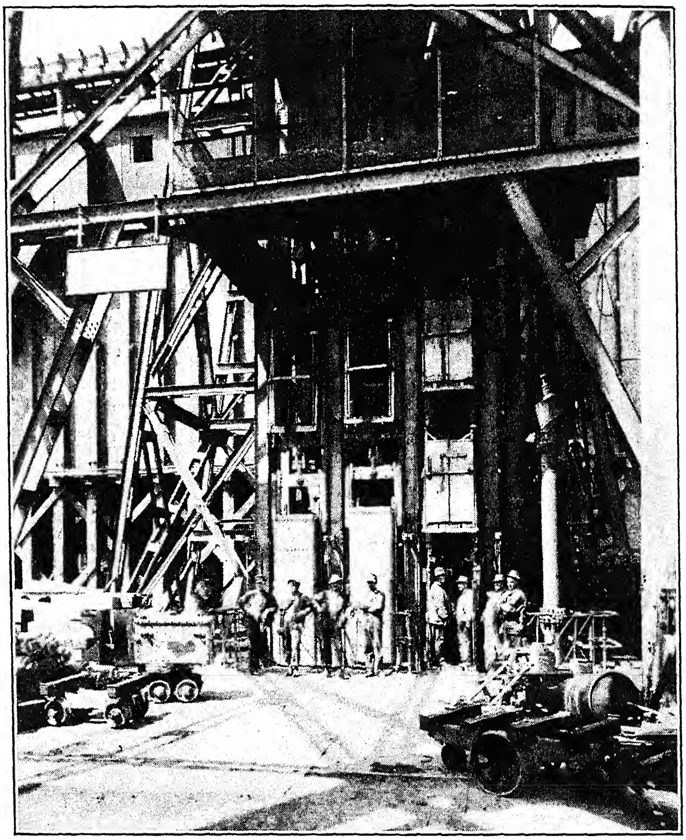

FIG. 59. Mine shaft at Butte. (*Photograph by Anaconda Copper Mining Co.*)

Tungsten. Some production of this valuable metal has come from the Northwest, chiefly from southern Stevens County, Washington, where the Germania mine has been the chief producer. The Jardine district in Montana, near Yellowstone Park, and the Blue Wing district, Lemhi County, Idaho, have ore deposits containing some tungsten.

Molybdenum. Occurrences of this metal are scattered throughout the Northwest and some development has taken place. Molybdenum has been found in Idaho and in the Wallowa Mountains of Oregon. It also

occurs in quartz veins in the northern Cascades of Washington. A small production has come from several small mines in southern Stevens County, Washington, that began operations in the 1930's

Titanium and Other Alloy Metals. One small deposit containing 25 per cent titanium is known in western Washington Many magnetites of the Pacific Northwest may contain compounds of titanium, but it is doubtful if any ores contain this in commercial quantities in the Region Some production of nickel has come from the Fraser Valley, 100 miles from Vancouver near the little towns of Choate and Yale. Nickel ores occur near Riddle, Oregon, and near Keller, Washington Cobalt veins are found in southwestern, central (near Canyon City), and northeastern Oregon, but no mining has resulted. Bismuth is produced on a small scale as a by-product metal by smelters at Anaconda, Montana, and Kellogg, Idaho, but no bismuth ore is mined primarily for the metal itself Cadmium is another by-product that comes from the Trail smelter Beryllium occurs in pegmatite deposits near Deary, Idaho, and other places in Idaho and Washington, but no worth-while production has yet resulted.

Gold

Placer mining for gold in the 1860's was the first metallic exploitation in the Northwest It was succeeded by lode mining, and in value of output gold is a leading metal in many districts of the Region. In all, over half a billion dollars in gold has come from deposits in Montana, Idaho, Oregon, and Washington during the eighty years, 1860-1940.

The Wallowas and Blue Mountains in northeastern Oregon have accounted for two-thirds of the total state production, with the remainder mainly from the Klamath Mountain region The Blue Mountains area contains some twenty-seven districts where gold quartz has been found in some quantity. The gold districts, extending from the Snake River to Canyon City, are distributed over a belt measuring about 100 miles long and 40 miles wide.

In the northern Cascades of Washington, gold has been mined in the Blewett, Swauk, and the Monte Cristo districts, and in several parts of Whatcom and Okanogan counties Gold also comes as a by-product from smelting copper ores produced at Holden near Lake Chelan which is now the largest producer in the state. The principal placer districts are in the Wenatchee Range, from which has come 3 million dollars in gold, and from bars along the Columbia River in Stevens and Ferry counties. The Republic (Eureka) district, Ferry County, has, since 1900, produced from veins more than 11 million dollars, the ratio of gold to silver in the ore being 1:8 The Orient district, Stevens

County, in 40 years has produced somewhat over $600,000 of gold-silver ore.

In British Columbia the main gold camps are in the southern part of the province at Bridge Creek, 150 miles north of Vancouver, Sheep Creek, and Hedley in the interior, and Zeballos on Vancouver Island The Nelson, Kamloops, and Ymir districts also are productive. Placers are important in the Cariboo region and in the northern part of the province. In 1940 the output of gold was approximately 25 million dollars from British Columbia, of which about 93 per cent was from lode deposits. In Idaho there are numerous low temperature and pressure veins carrying gold and silver. In Owyhee County the Silver City and other districts have produced ore valued at more than 40 million dollars Several districts in Lemhi, Custer, Butte, Blaine, and Valley counties have each produced important amounts of gold, but no locality has exceeded one million dollars total.

At one time Idaho was among the principal placer-mining states in the Union, and a large amount of gold is still obtained from placer deposits, central Idaho and Boise Basin leading in this respect The high-level placer deposits and the gold lode deposits offer greater opportunities than those of almost any other state. Idaho now ranks seventh in the United States in gold production. Gold occurs in association with almost all the lead, zinc, copper, and silver ores

Montana had the richest placers in the northwestern states Bannock, Virginia City, and Last Chance Gulch were discovered in 1862, producing a great influx of miners. Lode gold has been mined for over 60 years One-half of the gold produced comes as a by-product from the Butte district, and much of the rest of the gold is obtained mixed with other metals The total gold production has amounted to over 300 million dollars and yearly exceeds 7 million dollars. Among the important districts are gold-silver veins at Marysville, and other districts near Helena and Boulder, genetically connected with rhyolite eruptives. Gold mines are important at Phillipsburg, at Cable near Anaconda, and near Dillon. Usually the metal is in quartz veins mixed with silver and various sulphides.

The Northwest has been interested in Alaska mining for over 50 years, and after the "Gold Rush" to the Klondike and Alaska began in 1898 Seattle became the leading supply city and shipping port for the Alaskan mines. From 1880 to 1940 the value of minerals coming from the northern territory exceeded $830,000,000, of which gold accounts for $561,311,000. In 1940 the entire production of all minerals was estimated at approximately $27,658,000, nearly four times the purchase price of Alaska.

Silver

Idaho leads all the states of the Union in the production of silver, and Montana is in third place The Northwest, including British Columbia, is one of the most important silver-producing sections of the world. Idaho produces one-eighth of all the silver mined in the United States. Here it is associated with lead, copper, zinc, and antimony ores, and is widely distributed. Shoshone County ranks first, followed by Lemhi, Custer, Bonner, Boundary, Blaine, Owyhee, Camas, Valley, Washington, Idaho, Elmore, Adams, and Carrie counties. The largest producer of silver in the United States is the Sunshine mine in the Coeur d'Alene district. South-central and southwestern sections of Idaho, especially Cassia and Owyhee counties, have extensive deposits of lead or zinc and silver ores, and some copper-silver ores are known along the Snake River canyon.

In Washington silver-lead veins occur at Conconully (Ruby Hill), in Okanogan County, with auriferous quartz veins on the Methow in the same county, and in many other smaller districts The Deer Trail district of Stevens County produced one million dollars before 1909, chiefly in silver.

The silver of Montana has come primarily from the copper and zinc ores at Butte The ores are complex, and extraction of the metals gave difficulty in early years Since 1875, when successful recovery was first achieved, Butte has produced a total of one-half billion ounces in silver, and other districts at the rate of a million ounces a year. The total value is in excess of half a billion dollars. In Montana the Granite-Bimetallic intermediate lode in the border of a granodiorite batholith, near Phillipsburg, produced about 32 million dollars from secondary silver ores Other mines near Phillipsburg are fissure veins of the normal quartz-tetrahedrite-galena type At Neihart, in the Little Belt Mountains, over 2 million dollars was produced from 1881 to 1893, and the mines, reopened in recent years, now produce lead, zinc, and silver to an annual value of about $500,000

In British Columbia most of the silver ($9,750,000 in 1938) is a by-product from gold, copper, lead, and zinc mines Properties rich in silver alone, as in the Slocan district, are operated mostly when the price of silver is high. A little silver is produced in Oregon as a by-product of the mining of complex ores.

Copper

The Northwest is a huge producer of copper. Although Butte is the most famous, the metal comes in smaller quantities from a number of sources. Copper occurs as a principal element in some ore, but often

it, like gold, silver, lead, and zinc, is one of several elements obtained from a complex ore. In addition to copper, these ores yield sulphur and in turn sulphuric acid, usually manufactured to cut the cost of preventing escape of sulphur fumes into the air.

In Oregon chalcopyrite, copper iron sulphide, occurs at Waldo, some twenty miles southwest of Grants Pass. The production of copper from

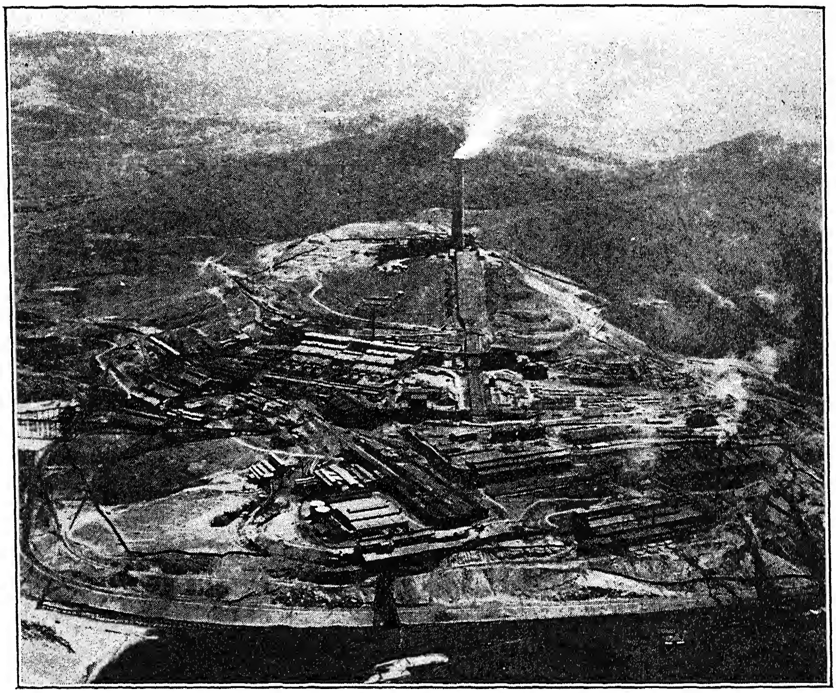

FIG. 60. Aerial view of reduction works at Anaconda. (*Photograph by Anaconda Copper Mining Co.*)

this district to date has amounted to approximately 3 million pounds in spite of high charges resulting from a long transportation haul to market. Copper ores are found in the Homestead district on the Snake River, where it occurs as chalcocite, copper sulphide, and chalcopyrite. Another important area in the copper belt is the lower Powder River Valley, where chalcopyrite, chalcocite, and cuprite, copper oxide, occur in disseminated ore. In the Wallowa district the mineral is mainly chalcopyrite.

Along the Snake River Canyon are some extensive but low-grade copper deposits that contain appreciable amounts of gold. Idaho's copper production comes almost entirely as a by-product of the silver

ores of the Coeur d'Alenes. Chalcopyrite-quartz veins occur in several districts in Idaho, as at the Lost Packer veins of the Loon Creek district. A number of small deposits are associated with the Idaho batholith in central and northern Idaho, as, for example, the Bonner, Vienna, and Flint districts, and from the Seven Devils and White Knob of Idaho

In Washington copper occurs in the northern part of the state. The only large producer is at Holden, from which 2,000 tons of ore per day are concentrated. The concentrates are then transported by lake, barge, and trucks to the railroad for shipment to the Tacoma smelter. In the Blewett district of south-central Chelan County the ore bodies are well-defined fissure veins. A number of quartz chalcopyrite veins have been developed in Stevens County, and in the Index and Sultan Basin districts of Snohomish County The Monte Cristo district lies in the eastern part of Snohomish County on the western slope of the Cascade Mountains. The ore deposits of importance are veins in joint planes in the Miocene igneous extrusive rocks, and were formed in late Pliocene or early Pleistocene time in connection with the later extrusive igneous action.

In Montana unexcelled deposits of copper occur in many places in the southwestern part of the state The intermediate veins systems of the Butte district carry copper mainly, with small amounts of gold and silver, but there are also veins rich in silver and zinc. The veins lie in the middle of the Boulder batholith, and have been worked to depths of 4,000 feet. The Butte district is the most productive copper camp in the world, having yielded from 1882 to the present over two billion dollars in copper, silver, gold, and zinc.

Copper ores are smelted and electrolytically refined at Tacoma, Washington, the plant treating Alaskan, British Columbia, and ores of the northwestern states. Smelters are also located at Anaconda and Great Falls, Montana, with a large electrolytic copper refinery and other works also at Great Falls, where cheap, abundant power is available from several falls on the Missouri River.

Most of the copper in southern British Columbia comes from two large operations. Until the discovery and development of the Rhodesian copper deposits, the Britannia mine, 30 miles north of Vancouver on Howe Sound, was the largest copper producer in the British Empire. It is still operating steadily, and in 1938 employed 1,168 men and turned out 6,000 tons of ore per day. The ores are concentrated at Britannia Beach, and the concentrates shipped to Tacoma for smelting and refining Copper Mountain, 100 miles east of Vancouver in the Cascades, employs 532 men, and produces 3,000 tons of ore per day In

1938 the total British Columbia output of refined copper was 65,000,000 pounds, valued at $6,500,000.

Lead and Zinc

In the early days zinc was considered a liability because of its refractoriness until, in 1916, the Anaconda Mining and Smelting Company set up an electrolytic plant at Great Falls, on which over 7 million dollars were spent in perfecting this process, by which zinc 99 9 per cent pure is produced. Owing to the great reserves and the cheapness with which it can be produced elsewhere, zinc is mined only as a secondary product with other ores, except during times of high prices for the metal.

At present there are no mines in Oregon operated primarily for the production of lead and zinc, although it is a common constituent of the base ores of gold and silver and occurs in several districts in greater or smaller quantities in both eastern and western Oregon. In the Cascade Mountains is a chain of low-temperature and pressure base-metal deposits extending from the vicinity of the California line to northern Washington. The most promising zinc prospect in Oregon is on the north Santiam River. Another potential district is Bohemia in Lane County. Both of these are on the western slopes of the Cascades.

Eighty-five per cent of the lead and zinc in the Northwest is produced in the plants of the Bunker Hill and Sullivan Company at Kellogg, Idaho, where lead, zinc, copper, gold, and silver are treated The company itself mines, mills, smelts, refines, and manufactures lead and zinc products, and also treats ores for other producers. Both a smelter and a "wet" process zinc plant are operated at Kellogg In the Coeur d'Alene district of Idaho, in Shoshone and Blaine counties, silver-lead and zinc deposits in quartzite have yielded well over one billion dollars Each ton of ore, as mined, contains about 8 per cent of lead (160 pounds) and 6 ounces of silver. These deposits have yielded a large percentage of the lead production of the United States and are the only important representatives of this type in the United States The ores occur as replacements and lodes along shear zones in fine-grained quartzite of the ancient Belt Series in a region marked by a number of small intrusive bodies. The rocks of the region are folded and strongly faulted, the mineralized fractures, however, are minor breaks. The ore bodies are rather wide, up to 40 feet, and average 9 feet. The more persistent veins have been followed several thousand feet The metallic minerals are galena and zinc blende, with some pyrite, and in places they carry much silver. Other lead districts in Idaho include the Wood River district, in the south-central part of the state, that has

produced around 20 million dollars, and the Bay Horse district, with an output of 10 million dollars from 1880 to 1898

In Washington, lead and zinc ores, without much silver, occur as replacements in limestone near Northport and Colville in Stevens County and in the Metaline district, Pend Oreille County The zinc mines at Metaline Falls are the leading producers of that metal in the state.

In Montana the mining of lead began in 1880 but zinc from complex ores was not profitable until the Anaconda Company perfected its "wet" process to recover the metal and then Butte became the chief source of zinc in the state. Butte also leads in production of lead, the metal being a by-product from other ores. Lead is also mined in noteworthy quantities in Sanders, Flathead, Jefferson, and Broadwater counties and at Neihart and Barker in the Little Belt Mountains Lewis and Clark County is second to Silverbow (Butte) in zinc production. Other minor centers for zinc and lead mining are scattered throughout western Montana

The Sullivan mine, in the Selkirk Mountains near Cranbrook, is the largest single lead and zinc producer in the world. In 1939 this mine was responsible for almost the total lead and zinc production of British Columbia. It employed 950 men, and produced 6,000 tons of ore per day. The mine's lead output amounted to more than 406,000,000 pounds, and that of zinc to nearly 280,000,000 pounds, valued at $13,500,000 and $8,250,000 respectively The total British Columbia production of lead in 1939 had a value of $13,810,024, and that of zinc $9,172,800.

Trail Smelter. One of the most important operations connected with the mining industry of British Columbia is the smelting and refining of ore at Trail The first smelter, constructed in 1895, treated copper ores from the Rossland mining camp. This camp played an important part in the early development of the Province, but has long since been worked out In 1898 the smelter was enlarged, and in 1901 began to treat lead as well as copper ores The operation has subsequently been enlarged many times, and it is now one of the most complete metallurgical works in the world. The smelter treats mainly lead and zinc ores from the Sullivan Mine; it also treats miscellaneous ores from many small mines. One of the interesting by-products from Sullivan ores is cadmium, which is used to make a fusible alloy.

The Trail plant covers about 160 acres on a narrow terrace on the west bank of the Columbia River, about 10 miles upriver from the Washington border. The two principal smelting departments are lead and zinc. The lead refinery has a capacity output of 575 tons a day.

The zinc refinery is the largest single producer of electrolytic zinc in the world, with 400 tons a day. In 1937 the silver output was 25,000 ounces a day; gold, 4,500 ounces a month; and cadmium, 25 tons a month. In addition, a small amount of antimony and bismuth metals was produced, and 60 tons of sulphur a day. The smelters gave employment to 3,200 men.

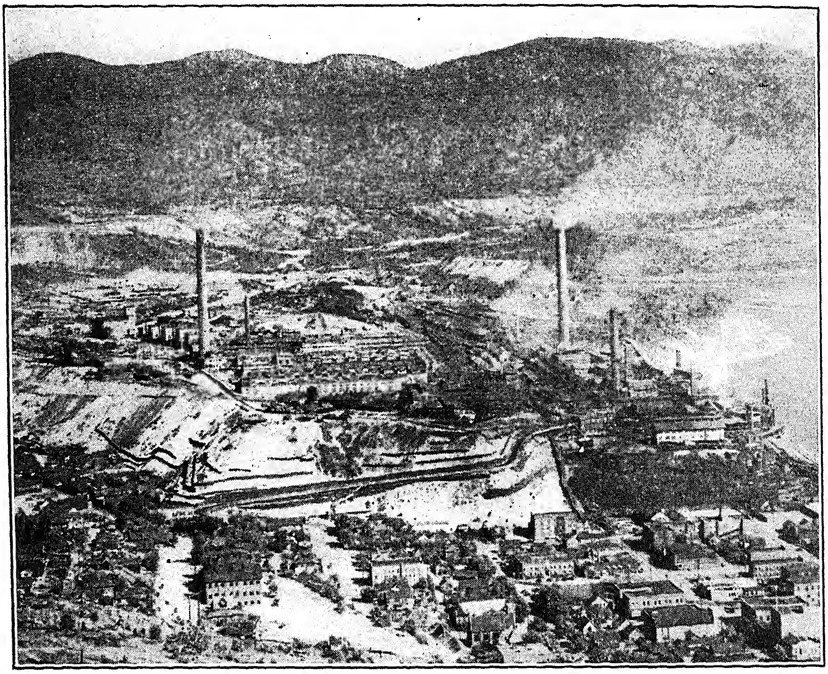

FIG. 61. Smelter at Trail, British Columbia.

The abundant sulphur fumes and the cheap electric power available were factors in the completion of a fertilizer plant in 1931. By-products of the smelting operations are utilized and phosphate rock is imported from Montana. The phosphate plant has a capacity of 450 tons of phosphate rock a day. The fertilizer plant covers 60 acres, and employs 560 men. Markets for its products are found on the Canadian prairies. Sulphur fumes from Trail formerly injured crops and trees, and the manufacture of acid and fertilizer has nearly eliminated the damage once done to the vegetation from this cause.

In 1937 the production at Trail of metals, chemicals, and fertilizers was as follows: gold, 52,435 ounces; silver, 9,846,545 ounces; copper, 4,585,000 pounds; lead, 413,158,000 pounds; zinc, 285,300,000 pounds;

cadmium, 218 short tons, sulphur, 13,533 short tons; 100 per cent sulphuric acid, 132,194 short tons; ammonium sulphate, 57,832 short tons; and other fertilizers, 44,221 tons. About 6,650 men are employed in all operations at the Trail smelter.

Mercury

Mercury (quicksilver) deposits, that comprise a belt in the Coast Ranges of California, extend northward into Oregon and Washington along the western flanks of the Cascades. Still another ill-defined belt runs through western Nevada, southeastern Oregon, and southern Idaho. The Ochoco Mountains of Central Oregon comprise another district The mercury is recovered in heavy liquid form by distilling the sulphide ore called cinnabar Usually the distillation plant is located at the mines In the Northwest mercury deposits occur in relatively recent lavas like basalt, andesite, and rhyolite. The constituents that formed them were held in the solutions close to the surface until a very late stage, hence they cannot be traced to any certain rock. It is assumed that they ascended from very deep magmas where the effusive rocks were differentiated.

In Oregon mercury has come mainly from the foothills of the Cascades in Douglas and Lane counties, also east of Prineville, Crook County, and close to the southern boundary of Malheur County Black Butte, in Lane County, has had a steady output since 1905 The largest producing quicksilver mine in the United States at present is the Bonanza Mine in Douglas County In Douglas and Jackson counties most of the deposits are enclosed in Eocene sandstone and tuffaceous strata, related to, but not closely restricted to, faults Locally, an overlying impermeable layer has apparently aided concentration of the cinnabar (quicksilver ore). In Crook County and adjacent parts of Jefferson County some of the lodes are rather sharply defined veins; others are networks of seams in brecciated rock In Malheur County, the Opalite Mine is an intermittent producer The lode consists of silicified tuff with cinnabar and terlinguite (a complex ore)

In Washington, deposits near Morton, Lewis County, have been somewhat productive and prospects are reported in Kittitas and Chelan counties. The lode at Morton is a breccia zone in Tertiary carbonaceous shale. The principal lode minerals are cinnabar, pyrite, and opaline silica.

Mercury deposits are known in the Yellow Pine district, Valley County, and the Black Pine district, Cassia County, Idaho, but the output has been small. Recently the Almaden mine near Weiser was discovered and is now an active producer of quicksilver.

A substantial production of mercury came for the first time from British Columbia in 1940.

Minor Minerals

Antimony. Deposits of antimonial ores occur in each of the four Northwest states and Alaska The smelting of the ores is a simple process, but no extensive western reduction plant is in permanent production. Most of the United States' consumption is imported from south China

In Oregon stibnite, commonly associated with gold and silver deposits, is found in both the northeastern and southwestern parts of the state. Ore has been sold from a mine south of Jacksonville. Small deposits of stibnite occur in seven or more counties in northern Washington, mostly in quartz veins associated with gold and silver. In Idaho antimony veins and replacement deposits occur in several counties, mostly associated with gold and silver. Only those in Shoshone and Valley counties are known to be of commercial value. The principal stibnite deposits of Montana seem to be those in the Burns district, Sanders county, fifteen miles west of Thompson Falls

Arsenic and Bismuth. Arsenical copper ores from which arsenic is produced occur extensively in Montana, and with other ores elsewhere in the Region White arsenic is a by-product of the Tacoma smelter, and at the Montana copper smelters Bismuth is another valuable by-product that is recovered at the Anaconda smelter.

Platinum. The principal production of platinum and closely similar metals comes from the Goodnews district of southwestern Alaska, where the output, all from placers, totals around $1,000,000 per year

Peridotite and serpentine derived from peridotite are generally considered to be the native rocks of platinum, and the abundance of serpentine in southwestern Oregon may account for its occurrence there, although platinum has not yet been found in place. The production is obtained chiefly from beach-placer deposits associated with black sands. It is also obtained in the smelting of copper ores at the Tacoma smelter.

Tin Seward Peninsula, Alaska, produces the only tin mined by the United States. The output comes from placers. In 1939 it amounted to 200 tons and was shipped to Singapore for reduction, as no tin smelter was in operation in this country Small occurrences of cassiterite, the ore of tin, have been found in a belt extending from the vicinity of Spokane to the Idaho line and just beyond

Gypsum Calcium sulphate is known in eastern Idaho and Montana and was formerly mined at Gypsum on the Snake River in Oregon.

The mineral is mined in Iyoukeen Cove at tidewater in Alaska. In Montana two plants for the preparation of gypsum products have been constructed near Lewistown in Fergus County, one at Heath and one at Hanover. Between Kamloops and Vernon, British Columbia, large deposits of excellent quality are worked. Stucco, plaster, kalsomine, wall board, and brick have been manufactured.

Saline Minerals. Lying on top of the lavas in the southeastern part of Oregon, southwestern Idaho, and eastern Washington are areas in which saline deposits may occur. Saline deposits generally result from evaporation of undrained lakes in arid regions. These deposits may include salt, borax, sodium carbonates, and nitrates, sodium sulphate and small amounts of potassium salts Brines heavily laden with common salt occur in southeastern Idaho and along the Wyoming border and in the adjacent portions of Utah Nitrate deposits are known in small volume in southern Idaho and eastern Oregon Large tonnages of sodium sulphate and sodium carbonate occur in the dry lake beds of south-central Oregon and north-central Washington. In these states an intermittent output has come from plants near Warden and Oroville. Near Clinton in British Columbia soda and magnesium sulphate are produced. Borax was formerly produced in considerable quantities from hot springs at the southern end of Steens Mountains

Sand and Gravel. Sand and gravel are abundant in all northwestern states, and in tonnage they probably amount to more than any other product Mixed and white dune sands of washable quality occur at intervals along the Oregon and Washington coast; white dune sands occur along the Columbia River eastward and northward from The Dalles, Oregon. Silica sand grains of glass-making quality occur extensively in the kaolins or China clays of eastern Washington and Latah County, Idaho Silica sands of washable quality occur as detritus from friable sandstones of the Swauk formation in central Washington Kaolinitic Eocene sandstones occur near Eugene, and at some places in the Coast Range of Oregon Foundry sands of good quality occur in Grays Harbor County and Clark County, Washington. Various other sand localities occur throughout the Pacific Northwest, but deposits have not been examined or tested for commercial use

Diatomaceous Earth This earth, made up of the siliceous cells of diatoms, is used principally as an insulator, absorbent, filter, filler, and abrasive. Large deposits of high-grade diatomite are located in central Washington and in central and eastern Oregon. This mineral is also known in many Idaho counties in the southern part of the state and in Nevada Diatomite exists in very considerable quantity in a district near Terrebonne, Deschutes County, Oregon. The deposit covers an

area of some 430 acres and is about 30 feet in thickness. The reserves, which are of commercial grade and suitable for filtering purposes, are estimated at about 7 million tons Production has thus far been confined to several thousand tons per year. A small production has come from near Quincy, Washington.

Vermiculite. This is a peculiar decomposition product of mica, sold under the trade names Zonolite and Unifill, that has been successfully mined from a large deposit in igneous dikes near Libby, in northwestern Montana. This new commodity is a complex silicate mineral similar to black mica, but which on being heated expands and exfoliates in very thin paperlike flakes, assuming a golden or silvery luster It is used for heat, sound, and electrical insulation, as decorative for wallpaper, and in the manufacture of wallboard.

Gems. The Yogo Gulch sapphires mined in Judith Basin County, Montana, have become world famous for their beauty in brilliancy and depth of color. The gems, which occur in igneous dikes cutting limestones, are mined, separated from the matrix by washing after the rock has been allowed to weather. The best gems are sent to Europe for cutting and the inferior stones are used for watches and other bearings For a number of years the annual value was nearly one-quarter of a million dollars, but production has been small in recent years and the mine is now closed, in part because of competition with synthetic gems A few sapphires are recovered by placer operations near Helena and Phillipsburg.

A considerable agate industry has been developed in the Northwest especially in the western part of Oregon, with the leading center at Newport.

REFERENCES

Numerous publications on minerals are available from the following agencies Consult their list of publications

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CHAPTER 9

FISHERIES OF THE NORTH PACIFIC

By Howard H Martin

The coastal waters of the Pacific Northwest are one of the few great areas in the world where natural conditions favor a maximum of marine life. Like its positional twin, Northwest Europe, it has a fortunate combination of broad continental shelf and warm and cold ocean currents—an environment in which phytoplankton and zooplankton thrive and multiply, providing the basic feedstuffs for the higher forms of marine animals. The pastures are literally enormous. The rugged littoral from Cape Blanco to the tip of the Aleutian Chain, and north of the Aleutians to Bering Strait, has thousands of islands and hundreds of protected bays, fiords, and inland passages Great rivers such as the Columbia, the Fraser, and the Yukon offer thousands of miles of spawning grounds for anadromous fish. Some inland waters such as Puget Sound are cold and deep; others like Willapa Harbor are warm and shallow. Lakes and streams are also available for fresh-water species.

With such a diversity of habitat it is not surprising that there is a wide diversity of commercial fish The latitudinal span is sufficient to encompass the codfish and the whale of the Far North as well as the warmth-loving tuna of southern waters In between are almost the entire range of temperate and cold-water types including many of the demersal or deep-sea dwellers, pelagic or surface-swimmers, like the herring, river-running fish, such as the shad and smelt, and the more sedentary mollusks and crustaceans Some North Pacific fish, including salmon and halibut, are found in sufficient abundance to take first rank in the world.

Fishing Bases

Nearly every harbor has a fishing fleet. Astoria, one of the oldest centers, is home port and marketing point for most of the Columbia River fleet. With its many canneries, icing plants, and reduction works, Astoria perhaps has a heavier per capita investment in fishing than any other city of its size along the coast Ketchikan, Alaska, is another town

almost entirely dependent on fishing Vancouver and Prince Rupert, B. C., and Bellingham and Aberdeen, Washington, are other examples of cities with extensive fishing interests.

More fishing vessels, however, are based on Seattle than on any other port, and most North Pacific fisheries products eventually pass through Seattle warehouses. The great center for the fleet is the Salmon Bay Terminals in Ballard. Here the moorings cover some 37 acres and sometimes winter as many as 300 fishing craft, including halibuters, trollers, purse seiners, and codfish schooners Warehouses provide ample storage for canned fisheries products, as much as $15,000,000 worth of canned salmon has been stored in this terminal at one time During the winter, boat owners overhaul their gear, install new engines, paint the vessels, mend their nets and trawls, and get ready for the opening of the spring season (Fig 62).

SALMON

The Annual Salmon Run. Just as the codfish is always associated with New England, salmon has become one of the symbols of the Pacific Northwest. Every spring and summer the rivers from California to Bering Sea are the scene of one of the world's most spectacular fish runs. Millions of salmon assemble at the river mouths, swarm across the bars, and move steadily upstream. Rapids and waterfalls are no deterrents. Driven by the spawning urge, salmon dart through swift water and around great boulders, leaping falls of considerable height A long run of a thousand miles up the Columbia to the headwaters of the Salmon River in Idaho generally begins in March or April. The short runs of Vancouver Island, where the spawning beds may be only a few hours from salt water, may not begin until late in the autumn. The salmon finally reach the original stream or lake where they were hatched several years before. Scooping out a shallow nest, they deposit and fertilize the eggs, then cover them with a layer of protecting gravel Pacific salmon take no food after leaving salt water Spent by the journey and the final act of reproduction, the parents lie quietly in eddies and die within a short time.

The eggs generally hatch in about two months, the fry emerging from the gravel in the spring. Depending upon species, the young salmon remain several months, sometimes as long as three years, in fresh water before beginning their trip to the ocean The salt-water phase of their life cycle lasts from two to six years, again depending upon the variety of salmon Their marine feeding grounds are not definitely known. Chinook salmon from the Columbia have been tagged off the Queen Charlotte Islands and later recovered in the

Columbia, and other varieties migrate long distances through the passages of southeastern Alaska.

Species of Salmon. Five species of salmon are found in the Pacific Northwest, including Alaska. Sockeye or Red salmon, weighing 4 to 10 pounds, have long been the favorite. An ideal cannery fish from the standpoint of size and color, the sockeye formerly provided most of the American pack, and still accounts for about one-quarter of it. The great Chinook or King salmon, averaging over 20 pounds and sometimes weighing as much as 100, are sold fresh as well as canned. Coho

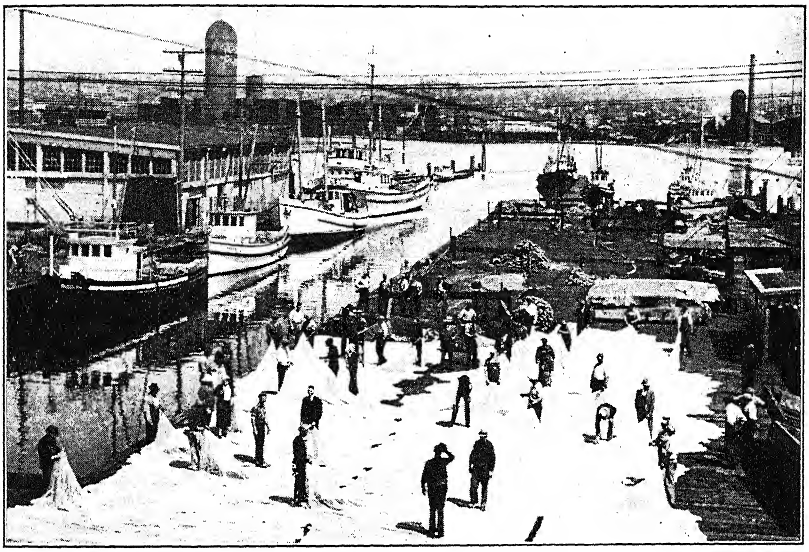

FIG. 62. Purse seine fishermen overhauling nets at Salmon Bay Terminal, Seattle. (*Courtesy Pacific Fisherman.*)

or Silver are less popular for canning because of their lighter-colored flesh. Humpback, or pink salmon, weighing 3 to 5 pounds, are the most plentiful, particularly in southeastern Alaska where they are caught in great numbers. Chum or Keta, white in color and formerly regarded as inferior, are also taken by many canneries. Steelhead trout are caught in some areas such as the Columbia River and sold as salmon.

Since generally food of an appealing color appears most appetizing to people, red salmon, such as those caught in Bristol Bay, Alaska, and other areas, command the highest price. Pink salmon and white salmon are not so attractive in appearance but have excellent food value; they now make up a larger share of the catch than the higher-priced red.

The Canning of Salmon. When the adult salmon assemble at the

mouths of the rivers for the annual spawning run, they are in the prime of condition and ready for canning. Packing plants are located along the coast from northern California to western Alaska, usually near river mouths. By means of traps, gill nets, purse seines, and sometimes beach seines, the fish are caught by the thousands. Traps, now illegal in the state of Washington, are widely used in Alaska, as well as in Oregon. Whether taken in trap or seine, the salmon are brailed out into huge scows often containing as many as 35,000 fish, which are then towed alongside the canneries (Fig 64) Conveyors hoist the fish to the cannery bins above the work floor.

TABLE 5

WORLD'S CANNED SALMON PACK—1940

(Cases of 48 pounds)

(From *The Pacific Fisherman*)

District	Red, Sockeye, or Blueback	Pink	Chum or Keta	Medium Red, Coho, Silver	King or Chinook	Steel-head Trout	Total (Full Cases)
Alaska	953,381	2,908,025	860,539	284,130	22,303		5,028,378
Puget Sound	62,748	2,947	23,405	30,654	1,674		121,428
Columbia River	23,974		25,282	59,737	244,570	33,436	386,999
U S Coast Streams	138		10,142	1,147	670		12,097
British Columbia	362,758	213,320	634,021	216,727	17,268	1,007	1,445,101
Siberia and Japan	616,978	1,079,546		86,557			1,783,081
Grand Total	2,019,977	4,203,838	1,553,389	678,952	286,485	34,443	8,777,084

The modern cannery is completely mechanized, and its methods are those of high-speed mass production. An ingenious machine known as the Iron Chink[1] butchers salmon at the rate of 60 per minute. Head, tail, and fins are removed, and rotating knives and brushes finish the cleaning work. The salmon on a moving conveyor are then cut into suitable pieces and fed into the cans by a filling machine The cans are weighed, the tops clinched on, and then sealed in a vacuum sealing machine. An assembly line of this type can deliver a stream of cans to the cylindrical cooking retorts at the rate of 120 to 150 cans per minute Steam-cooked for 90 minutes or more, the cans are then cooled, packed in cases (the standard-sized case contains 48 pounds of fish), and are ready for warehousing or distribution.

There are some eighty recognized canning companies in the Northwest, but eight or nine leading packers market about two-thirds of all

[1] This machine, invented by a Seattle mechanic about 1905, is called the Iron Chink because it takes the place of the many Chinese cutters who formerly did the work by hand.

the Alaska and Pacific Northwest salmon. No matter where salmon is canned the larger part of it eventually reaches Seattle for distribution.

The Trade in Fresh Salmon. Although most of the Northwest salmon are caught for the canneries, several million pounds are iced or frozen for sale fresh, particularly in the Pacific Coast states. Most of the fish for this market are taken by trolling, the Chinook, or King salmon, and the Silver being the favorites and bringing the highest prices. Both

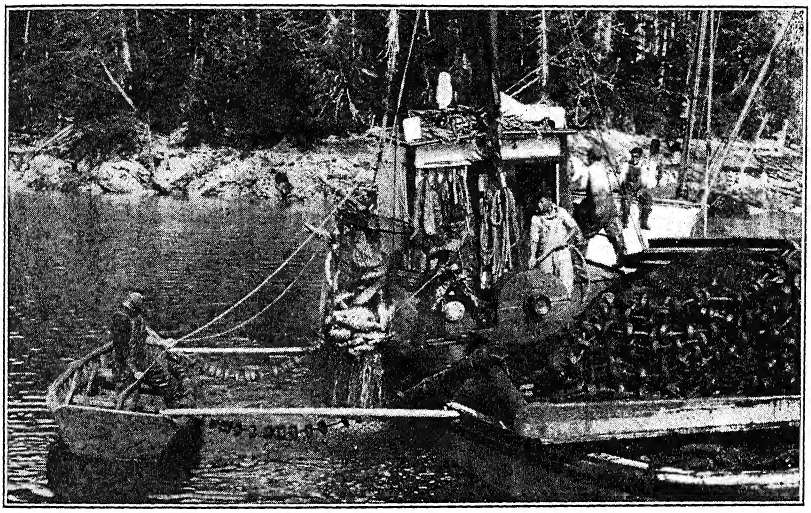

FIG. 63. Brailing the last of a salmon catch from a purse seine. (*Courtesy J. Walter Thompson Co.*)

these varieties feed on small fish such as pilchard or herring, and can be taken on hand lines using bait or spoon hooks. The trollers dress and ice their catch at once, generally landing them in Seattle where several companies specialize in this business. Portland, Vancouver, B. C., and Astoria also buy and distribute fresh salmon. Traps are occasionally used, and some fish are taken by seines and gill nets. Part of the catch is also frozen preparatory to making smoked, mild-cured, or kippered salmon.

Fresh salmon, not as common a table fish in the East as the well-known halibut, deserves a wider market.

Northwest Salmon Pack. Salmon canning in the Northwest began at White Cliffs on the lower Columbia River in 1866, with a small experimental pack of 4,000 cases. Wherever offered for sale, this new type of foodstuff met with such favor that operations were immediately increased manyfold. Canneries sprang up along the Columbia, in Puget

Sound waters, and in all the rivers along the coast of Oregon and Washington. The small coastal rivers reached a peak of about 250,000 cases in 1911, the pack in the same area is now less than 15,000 cases per year. The Columbia River, a steady producer for over sixty years, reached its maximum of 634,000 cases in 1895. Since then the teeming sockeye runs in the Columbia have shrunk to a fraction of their former size. Canning has held up fairly well through the substitution of other varieties, especially the king, but since 1930 the average Columbia pack has been about half that of 1895 The Puget Sound area, with the richest salmon waters within the United States, has had an even more drastic decrease. The great runs of both sockeye and pink salmon were canned to the extent of over 1,000,000 cases per year from 1899 to 1919, the Puget Sound pack was 398,000 cases in 1939 and 121,000 in 1940. This steady decline of salmon in the Northwest States was somewhat obscured by the rapid rise of Alaska fishing, which was more than sufficient to keep up the supply available for market

Alaska Salmon Located along 10,000 miles of coast line, the salmon fisheries of Alaska are one of the richest natural resources of the North Pacific. They have an average fresh-fish value of $7,000,000 to $10,000,000 annually; the bulk of the catch is packed and is then valued at $30,000,000 to $40,000,000.

The first salmon cannery in Alaska was established on Prince of Wales Island in 1878, and by 1888 the pack exceeded that of the Columbia River. More and more canneries were established in the North to take advantage of the seemingly inexhaustible supply, the industry finally reaching a peak of 6,677,000 cases in 1918 under the stimulus of war prices. During the ensuing decade the pack dropped to an average of 4½ million cases per year, then began to increase, reaching an all-time peak of 8,437,000 cases in 1936, with an average of 5 to 6 million cases annually since then. Approximately one-half of the Alaska salmon are taken in fixed or floating traps, one-quarter by gill nets, and the other one-quarter in purse and beach seines. Very little trolling is done in these northern waters. Among the territory's most important salmon areas are Bristol Bay, the Kodiak district, and Prince William Sound, Ketchikan has long been the great canning center of southeast Alaska (Fig. 66). Steamers from Washington and Oregon go north each summer with cannery workers, equipment and supplies, returning in the autumn with heavy cargoes of canned salmon As the runs fluctuate considerably from year to year, none of Alaska's more than one hundred canneries is ever able to estimate its pack with accuracy.

Overfishing Brings Regulation. In its early years this industry was unregulated, and cut-throat competition was rife among canners. Cer-

tain of the streams were blocked so completely by traps that there was practically no escapement of fish ascending to spawn. After a few years of heavy packs but scant returns of young salmon, the canneries had to be abandoned. Most streams showed some decrease, and apprehension was felt lest the profitable Alaska fisheries follow the Atlantic salmon industry into oblivion.

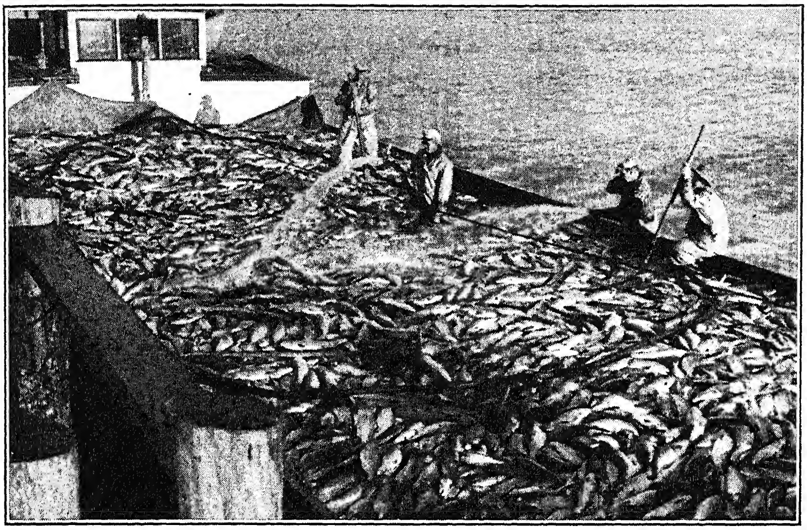

FIG. 64. Sluicing 35,000 Bristol Bay Reds from scow to cannery elevator, Naknek, Alaska. (*Courtesy Ruben L. Jensen.*)

For many years there was a struggle between interests in favor of unrestrained operation and fisheries experts who pointed out the necessity of restriction if the industry was to be preserved. The proponents of stronger regulatory measures were, as usual, accused of "trying to lock up the resources of Alaska," but in 1924 the White Bill gave the U. S. Bureau of Fisheries (now the Fish and Wildlife Service) supervisory and enforcement powers over all fishing in the northern territory. The most important feature of the bill provided for at least a 50 per cent escapement of all salmon entering the rivers to spawn.

Management for Restoration and Stabilization. Since salmon with few exceptions return to the home stream, each of the Alaskan rivers is now managed separately. A badly depleted area may be closed for a term of years, and the regulations relaxed when the run again approaches normal. For instance, under this provision the 1934 regulations closed 93 fish-trap sites, at the same time opening a number of previously closed fishing grounds to seines and other forms of gear.

Despite this seemingly drastic restriction, the 1934 pack exceeded that of 1933 by 2 million cases.

The red salmon area of Bristol Bay, one of the most valuable fishing waters in Alaska, has needed special care. The Bristol Bay sockeye matures in a five-year cycle, and there was a steady decline in the 1920-1925-1930 runs, although the other years remained close to normal. In order to give this particular cycle a chance to rebuild, the Fish and Wildlife Service limited Bristol Bay to a very short season in 1935; the larger spawning escapement that year has improved the 1940 run although it is still far below the average. Traps are prohibited in this area, all fishing being done with gill nets. In addition to regulating the type of gear the Fish Service maintains a number of patrol boats in Alaskan waters.

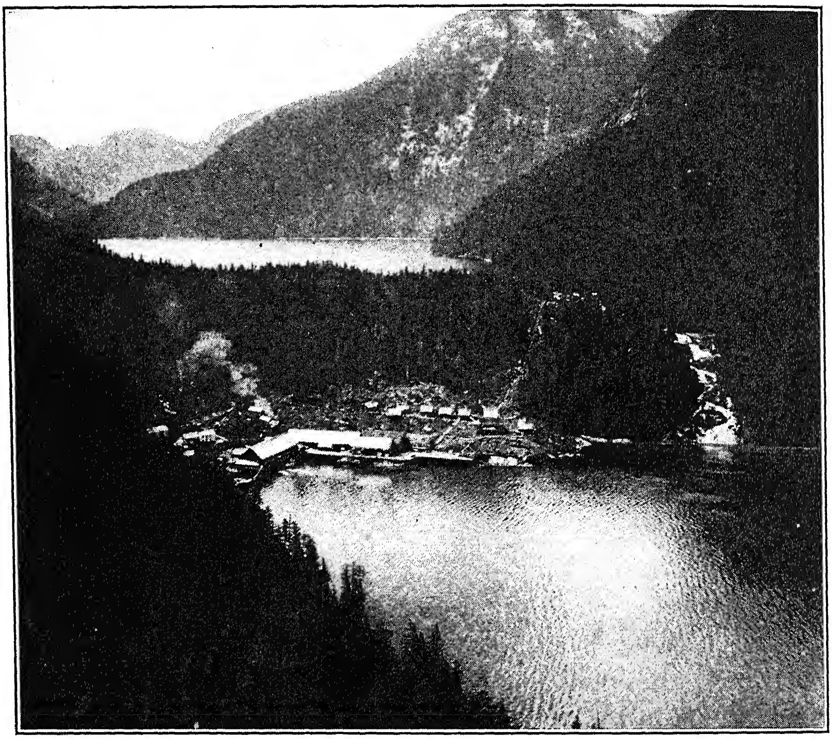

FIG. 65. Salmon cannery on coast of British Columbia. The water supply comes from the lake above, towards which the salmon migrate up the swift stream. The cannery and living quarters are on tidewater.

Under these wisely flexible regulations, the Alaskan salmon pack has been kept up with a minimum of interference with individual

fishing rights Although it is difficult to satisfy all interests, regulation has met with general approval, largely because it has stabilized the industry and placed it on a permanent basis. Few Alaska operators would now care to go back to unrestrained competition

Sockeye Decline in Puget Sound and the Fraser River Although the Alaska salmon situation has been improving steadily since 1924, the Puget Sound catch has shown an alarming decrease to a fraction of its former supply. Although all species of salmon are caught in the Sound, the sockeye is regarded as the most important In the main, the sockeye entering Puget Sound are bound for the Fraser River Basin of British Columbia, which is exceptionally well supplied with spawning grounds. On their way through the Sound to the Fraser the sockeye are exposed to an array of cannery traps, to numerous purse seiners clustered around the entrance, and to gill netters in the mouth of the Fraser.

Since both Canada and the United States had vital stake in the imperiled Fraser runs, a treaty was proposed in 1907, providing for a joint commission to investigate the problem The measure was passed by Canada but defeated in the United States Senate During the ensuing thirty years two similar treaties were approved by Canada but held up by certain American interests Throughout that entire period intensive fishing continued and the Fraser River-Puget Sound sockeye pack declined steadily.

The Sockeye Salmon Treaty In 1937 a treaty was finally ratified providing for the creation of the International Pacific Salmon Fisheries Commission, with three representatives from each country. By this time the sockeye runs were so small that drastic rehabilitation work was obviously necessary Canada agreed to make the entire Fraser Basin available for restoration and propagation, the cost of hatcheries to be borne jointly The research staff of the Commission began investigation in 1938, and will study the sockeye through two complete cycles lasting eight years in all, before regulation is begun. With the data obtained the Commission will then draw up control measures, and if possible rebuild the badly decimated runs

Bonneville and Grand Coulee. Included in the problem of salmon conservation on the Columbia are two dams, Bonneville and Grand Coulee, each of them higher than any obstacle formerly surmounted by anadromous fish. The 30-foot Rock Island dam constructed some years ago on the middle Columbia south of Wenatchee is equipped with fish ladders which have been quite successful in allowing passage for the salmon on their way to the spawning grounds The 65-foot Bonneville dam on the lower Columbia also has an elaborate system of fish ladders and elevators. Once above Bonneville the fish have access to

various tributary waters, including the entire Snake River system. Passes have also been constructed so that fingerlings on their way down river can reach the lower side of the dam safely.

The 350-foot Grand Coulee dam on the middle Columbia, however, is an impassable obstacle. Future salmon runs will be completely blocked at this point, since it is economically impracticable to convey fish over a barrier of this height. It is estimated that 1,100 linear miles of salmon streams in the upper Columbia basin of Washington, Idaho,

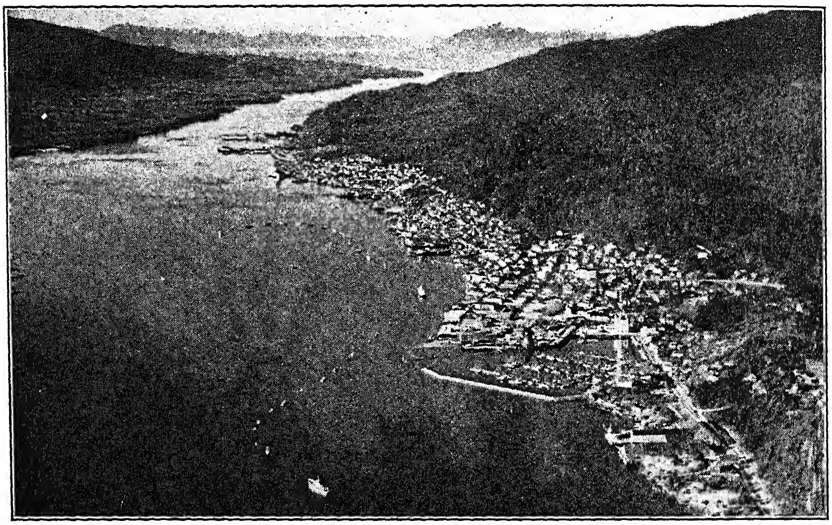

FIG. 66. Ketchikan, fishing and canning center of southeast Alaska, located on Tongass Narrows. Prince of Wales Island in the distance. (*Courtesy Schallerer's Photo Shop.*)

and British Columbia will thus be lost for spawning. To offset this reduction an elaborate system of artificial propagation has been planned on the Wenatchee River and other tributaries below Grand Coulee. Adult salmon caught in traps at Rock Island dam will be transported overland in tanks to hatcheries, and stripped of their eggs, which will be fertilized and hatched. Young salmon will be fed until they reach the proper size to join the downriver migration to salt water. In this way it is hoped that Columbia River salmon can be kept at the present level of abundance.

HALIBUT

Position in the American Market. One of the standard food fishes of America is the halibut, a great deep-sea flounder, dark on its upper or

right side, white on the left or under side. The North Atlantic halibut banks supplied the American demand for many years. It was not until some fifty years ago, after the inauguration of fast transcontinental rail service between Puget Sound and the eastern United States, that Pacific halibut entered the market in quantity. With the steady decline of the Atlantic grounds shipments from the Northwest increased in significance. The proportion of Pacific to Atlantic halibut is now approximately 13 to 1.

Life Cycle of Halibut. Salmon mature in 4 or 5 years, but most halibut do not reproduce until they are 12 or 15 years old, approximately half of them mature at 12 years, and only a few as early as 8 or 10 years.

The parent fish gather in schools along the edge of the continental shelf and spawn during the winter, December to March. Deposited in about 150 fathoms of water, the eggs rise to moderate depths and drift with the currents. After the tiny halibut are hatched they work gradually toward shore, spending the early part of their life in relatively shallow water, before settling down to much greater depths Their migration range is small, a fish usually spending its entire life in or near one bank. Halibut live to an age of about 25 years When caught they weigh anywhere from 4 to 200 pounds, but a few giants reach 250 to 400 pounds. A record fish of 1936 tipped the scales at 325 pounds.

The Halibut Fleet of the North Pacific. The halibut banks follow the continental shelf from northern California to the Bering Sea. The fishing fleet, now consisting of about 350 boats, is both American and Canadian, the latter taking about one quarter of the North Pacific catch. Over half the vessels operate out of Seattle. Prince Rupert and Vancouver are the main home ports for Canadian vessels, Ketchikan, Petersburg, and Juneau, Alaska, and Astoria, Oregon, have smaller fleets. The combined fleet employs 2,500 men, 1,800 of them Americans and 700 Canadians.

The boats, of sturdy design to withstand all sorts of weather, range in size from 35 to 90 feet and are nearly all Diesel powered The smaller ones which fish the southern grounds nearer to port have crews of two to six, but the larger vessels carry eight or ten men. Hand-line fishing from dories long ago disappeared. Halibut are now caught on long bottom lines strung with a series of shorter lines baited with herring, this unit of gear, called a "skate," is usually set at depths varying from 50 to 175 fathoms. Modern vessels operate as much as 8 miles of lines carrying 4,000 hooks, the heavy gear being raised and lowered by a power-driven winch The larger and better-equipped vessels with

considerable cruising radius operate as far away as the Gulf of Alaska and out around the Aleutian Islands.

Marketing the Catch. Dressed almost as soon as they are taken off the hook, the halibut are packed in crushed ice in the vessel's hold. The run to port is made as rapidly as possible. With its proximity to the

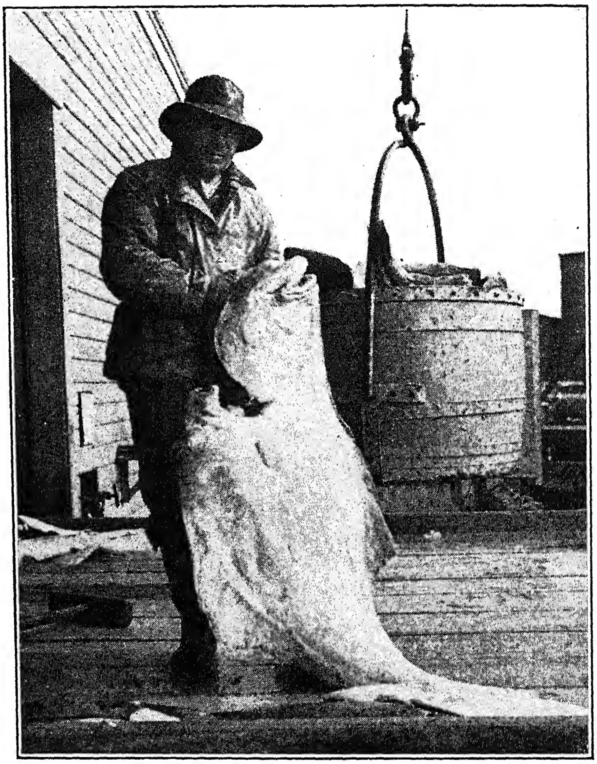

Fig. 67. This halibut is classed as a "whale." In the unloading bucket behind are several dozen mediums. (*Courtesy Pacific Fisherman.*)

richer banks Prince Rupert has an advantage over Seattle as landing port. In order to avoid the long trip home, many vessels which normally sell in Seattle often unload their catches at Prince Rupert, then hasten back to the banks for more fishing. The port and shipping center for most of the catch, however, is Seattle.

The fish are sold at auction, usually to large wholesale houses with their own docks and refrigeration plants. There the fish are unloaded, sorted, graded, and packed in ice in 200-pound boxes for shipment. Small halibut weighing less than 10 pounds are classed as "chickens," those 10 to 60 pounds as "mediums," and those over 60 pounds as

"large" or "whales" (Fig 67). So systematic and efficient is the handling that a cargo of halibut may reach Seattle in the early morning, be auctioned and unloaded before noon, graded and boxed in the early afternoon, and sent on its way east by fast railway express that night

The flesh of the halibut is unusually firm and is well suited to long-distance transportation Sixty per cent of the catch is shipped at once as fresh fish, the rest is frozen and held in storage for gradual release, particularly during the closed season from November to April Like the better-known cod, the halibut has a liver rich in vitamin oils, which drug concerns now buy at high prices, an additional source of income to the fishermen.

Depletion on the Halibut Banks. In the early 1900's most of the fishing was on the southern grounds within a radius of about 500 miles from the base ports Gradually, as the abundance declined in this area, vessels pushed farther north into Alaskan waters returning with even larger cargoes of fish Peak production was reached in 1915 with 63,000,000 pounds To keep up the catch both Americans and Canadians went farther and farther to sea, fishing more intensively Finally the limits of lateral expansion were reached and three definite evidences of depletion appeared.

1. Few halibut were being taken on the southern grounds, which had been worked longest and hardest

2 The proportion of mature fish was decreasing, a larger share of each catch consisting of "chicken" or small, immature halibut

3 The catch per skate or unit of gear had declined alarmingly In the early days the average catch per skate was about 300 pounds, but soon after 1920 it dropped to 60 pounds

The public was not aware of any depletion since the normal amount of fish was still reaching market Fisheries experts, however, pointed out the basic unsoundness of the situation and the probability that the Pacific banks were faced with a decline similar to that already in effect in the Atlantic. Authorities were convinced that this situation could not continue indefinitely without reducing the Pacific halibut to insignificance

Work of the International Fisheries Commission. Accordingly, the International Fisheries Commission was created in 1924, with a membership of two Americans and two Canadians It was given authority to study halibut and recommend conservation measures By research the long-concealed life history of this deep-water fish was finally obtained, and it was then possible to make recommendations for control and restoration.

TABLE 6

PACIFIC HALIBUT CATCH BY AREAS—1932 TO 1940

(Pounds)

(From *The Pacific Fisherman*)

Areas and Fleets	1932	1933	1934	1935	1936	1937	1938	1939	1940
Area 1									
American	902,271	722,254	1,541,258	1,489,294	708,301	709,752	706,316	1,072,675	760,872
Area 2									
American	16,026,631	14,880,259	13,360,103	13,112,709	13,865,731	13,445,575	13,737,819	13,466,002	14,407,041
Canadian	5,960,640	7,649,400	9,004,714	8,954,740	8,696,865	9,852,348	9,571,461	10,913,035	10,744,591
Total Area 2	21,987,271	22,529,659	22,364,817	22,067,449	22,562,596	23,297,923	23,309,280	24,379,037	25,151,632
Area 3									
American	21,146,037	22,887,941	22,829,989	22,532,977	23,717,665	23,551,917	22,820,005	22,761,120	25,268,616
Canadian	451,761	637,072	726,658	1,251,314	1,887,788	1,912,966	2,623,208	2,552,125	1,576,791
Total Area 3	21,597,798	23,525,013	23,556,648	23,784,291	25,605,453	25,464,883	25,443,213	25,313,245	26,845,407
Total American	38,074,939	38,490,454	37,731,350	37,134,980	38,291,697	37,707,244	37,264,140	37,299,797	40,436,529
Total Canadian	6,412,401	8,286,472	9,731,372	10,206,054	10,584,653	11,765,314	12,194,669	13,465,160	12,321,382
Grand Total	44,487,340	46,776,926	47,462,722	47,341,034	48,876,350	49,472,558	49,458,809	50,764,957	52,759,911

Four main regulatory measures were applied to the industry, and they have now been in effect for nine or ten years.

1. A closed period of four or five months during the winter spawning season The 1940 halibut fishing season opened April 1 and closed at the end of October.

2 The creation of certain nursery areas where fishing is entirely prohibited for the present These areas serve much the same purpose as wildlife refuges

3 A catch limit which may be raised or lowered at the discretion of the Commission, 52,700,000 pounds was permitted in 1940

4 The division of the fishing grounds into three areas, with separate regulations for each These areas are

I. South of Willapa Harbor
II Willapa Harbor north to Cape Spencer, Alaska
III Cape Spencer to the Aleutian Islands

Area I has suffered the most drastic depletion and is closely regulated More latitude is permitted in Areas II and III, which have not been as badly overfished. Alaskan waters are now providing most of the catch (Table 6)

Regulation Brings Increased Abundance. All the regulations have been strictly enforced and are now generally favored by the fishing industry Knowing in advance the poundage of fish to be marketed throughout the year has also helped to stabilize prices Even in this relatively short period the stock of adult fish on all banks has shown an appreciable increase. The average catch per unit of gear on the badly overfished southern banks was 65 pounds in 1937, in comparison with 35 pounds per unit at the low point in 1930. Already certain fishing interests are asking that restrictions be relaxed, but the Commission points out that the increase is yet too small to risk overfishing. The Commission hopes not only to perpetuate the Northwest halibut fisheries but also, if possible, to restore them to their former higher level.

SHELLFISH

Oyster Culture The natural habitat of the oyster, a shallow bay or estuary where the tides sweep in and out to bring him food, is found in several places along the North Pacific. Puget Sound had its native beds of small Olympia oysters, but they were overexploited and the industry was declining After some scientific study baby oysters, called "seed," of a type long cultivated in Japan, were imported and planted in Willapa

Harbor. The venture was a success, the oysters grew large and plump, and individual cultivators embarked on a new sea-food business

With its 100 square miles of shallow-tide flats, Willapa Harbor has excellent conditions for growing the Pacific oyster, as the introduced species was called At low tide large acreages of bay bottom are laid bare, making it easy for cultivators to inspect and harvest their crop For some years new oyster "seed" was imported annually, but in 1936 the first big set of young oysters occurred, and imports from Japan are declining. Oyster culture has also spread to some of the tide flats in Puget Sound, Coos Bay, and Grays Harbor. As a result there now exists an aquicultural industry worth more than a million dollars annually

While there is a big coast trade in fresh oysters, the Pacific bivalve is also planted, cultured, and harvested for canning Large barges can be floated over many of the shallower beds at high tide, filled when the tide is out, and towed to canneries conveniently located around the bay. In deeper waters the crop is tonged from the bottom At the cannery oysters are opened by shuckers, or placed in large cylinders where they are steamed open. The small towns around Willapa do 80 per cent of the Northwest canning, which has been increasing steadily during the past decade, reaching 166,000 cases in 1940

Clams Two varieties of clams, the razor and the hardshell, make up the Northwest catch of this valuable shellfish. The razor clam is the best known, but is found only in a few restricted areas along the north Pacific Coast The best grounds are the hard sand beaches of Washington north of Grays Harbor, and the Alaska coast near the mouth of the Copper River. Smaller amounts are taken along the Oregon coast

The Pacific razor clam, famous for its size and the whiteness and firmness of its meat, buries itself in clean sand and must be hand-dug with a spade, the harvesters often working knee deep in the surf. When tides are quite low the diggers make their best bags. During the Washington clam season, from March 1 to June 1, thousands of harvesters are busy, selling both to the fresh trade and the canneries The Washington pack of razor clams, 47,000 cases in 1940, is the leader in the market Fresh clams are also sold locally along the Pacific Coast but are seldom shipped to the eastern United States. The dig has been greatly intensified in recent years, and the pressure upon this edible mollusk is increasing so fast that stronger regulatory measures are needed.

Alaska clams in the Copper River district are taken entirely for canning, which began in Cordova in 1916. This ground has also been worked so intensively that the Fish and Wildlife Service has put the packers on a quota, 41,000 cases were canned in 1940.

Hardshell clams are found in various beds around Puget Sound, and canneries operate in a number of Sound cities, such as Seattle, Olympia, Everett, and Sequim. British Columbia also has a small hard-shell pack.

Crab and Shrimp. With three special centers of crab fishing, the lower Columbia, Coos Bay, and Yaquina Bay, Oregon is the Northwest

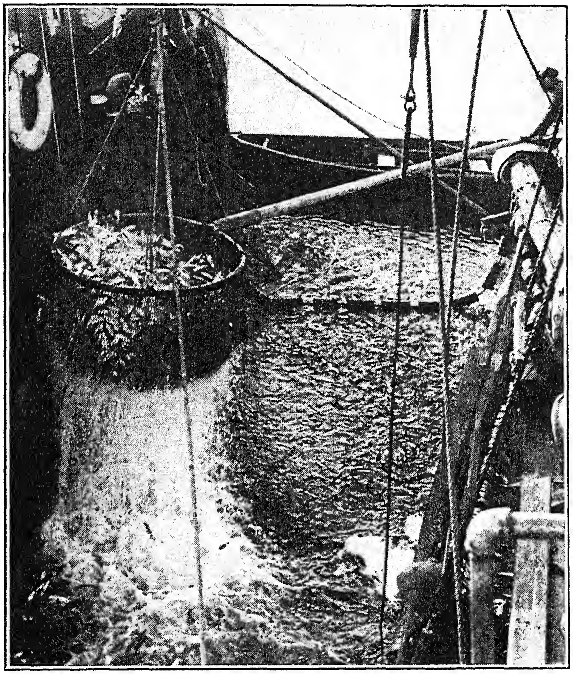

FIG. 68. Brailing herring from a purse seine, Prince Rupert, B. C. (*Courtesy Pacific Fisherman.*)

leader in this type of shellfish. For many years crabs have ranked second only to salmon in Oregon fishery production, and more meat has been sold fresh than has gone to the canneries. Alaska has a large canning industry, with Cordova as the chief center. The Dungeness type of crab has long been the mainstay, but the catching and the canning of Alaska king crabs are now beginning.

Six or seven commercial varieties of shrimp are found in the bays and sounds of the Northwest, with Alaska, British Columbia, and Puget Sound as the main sources. These small shellfish are caught either by trawls or seines. Most of the Alaska take is canned, but in the Puget Sound area the demand for fresh shrimp absorbs most of the catch

TABLE 7

FISHERIES OF THE PACIFIC NORTHWEST, 1938*

(From *The Pacific Fisherman*)

Catch (In thousands of Pounds and Dollars)

Varieties	Oregon		Washington		Alaska		British Columbia		Total
(Selected)	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Value
Salmon	20,821	$1,384	39,576	$2,565	589,705	$9,943	173,466	$6,331	$20,224
Halibut	409	27	23,084	1,875	19,366	980	12,024	840	3,724
Herring			341	3	179,735	898	132,891	316	1,219
Pilchard	34,035	187	52,976	291			103,536	453	932
Oysters	203	12	8,640	705			2,979†	36	754
Crab	6,409	291	2,612	116	935	86	794	25	519
Albacore (Tuna)	5,868	268	4,132	185					454
Cod‡			10,351	141	960	4	6,185	260	405
Clam	196	32	1,987	254	798	39		69	395
Whale					4,874	179	310§	184	363
Flounder (Soles)	218	3	5,083	145	257	7	873	44	200
Sablefish	124	3	2,768	113	1,289	38			156
Trout	1,860	114	403	25	98	6			146
Smelts	528	35	2,995	86			73	6	128

* U S Fish and Wildlife Service
† Barrels
‡Includes red, rock, and ling cod
§ Number of whales

brought in by the trawlers Shrimping in Puget Sound is another example of methods too severe for replenishment. Each new bed discovered has been cleaned out and then abandoned, so that today the Sound produces less than one-quarter of the shrimp caught from 1900 to 1915. Hood Canal is the best remaining shrimp ground inside the Sound

MINOR FISHERIES

Herring and Pilchard. Another pelagic fish, the herring, is also numerous on the Pacific Coast, particularly from Washington to Alaska. Alaska and British Columbia now provide the bulk of the catch, valued at $1,200,000 annually Purse seining is the most common method of taking herring, and thousands of barrels are processed for food, oil, meal, fish bait, and fertilizer. Alaska herring intended for food are generally salt packed and eventually landed in Seattle for further processing The preparation of Scotch-cured herring in Alaska has declined greatly since its peak years in 1922-1925. A small portion of the catch is smoke cured or kippered. Alaska now markets about 85 per cent of the total United States production of herring British Columbia boats also operate in the north Pacific during the annual run, and have the second largest production.

Pilchard, sometimes called sardines, are taken in purse seines in much the same manner as herring. Generally found farther south than herring, they are caught freely all along the British Columbia, Washington, and Oregon coasts. Most of the Northwest catch is landed at oil and fish-meal reduction plants Many Pacific Northwest pilchard boats operate in California waters from July to January, marketing their catch at reduction plants in the San Francisco Bay district. In 1940, they constituted nearly one-half of the pilchard fleet off San Francisco, at the end of the season they return to Astoria or Puget Sound

Albacore Tuna. Newest fishing venture in the Northwest, the catching of albacore off the Oregon-Washington Coast, has recently assumed large proportions. For the thirty years preceding 1937 the catching of albacore, yellowfin, bluefin, and skipjack for canning as tuna was almost entirely a California business All types of tuna were taken in warm waters from California far south along the Mexican west coast. Trollers off the mouth of the Columbia began to take albacore in quantity about 1937, and salmon packers in Astoria began to can them. Firmest and whitest of the tuna family, albacore form almost the entire Northwest catch, individual fish averaging 15-20 pounds in weight. Trolling is the standard method used, the albacore striking freely at lures during the season. The Washington-Oregon albacore are warm-weather fish and do not begin to run until July, few fish can be taken

after October In addition to the trollers, a number of purse seiners fish for albacore The record Northwest catch of 12,000,000 pounds in 1940 includes about one million pounds taken by California boats

Tuna canning methods differ considerably from those used for salmon When boated the albacore are packed in ice until the cannery is reached, then dressed, washed, cooked in live steam, and cooled. Trimmers then remove the skin, bones, and dark meat, separating the fish into four sections, each called a loin. Cut into sections by a guillotine knife, the tuna is then hand packed in cans, sealed, and given another brief cook to sterilize it. Many new tuna-canning units have been built in Astoria and Grays Harbor, which at present are the centers of the new industry.

Bering Sea Codfish. Another deep-sea fish, the cod, is caught mainly in Alaskan waters, and especially in the Bering Sea. These banks are worked during the season, from April to September, by a fleet of picturesque sailing schooners from Seattle and Aberdeen. They carry crews of twenty-five to forty men, who still use individual open dories and hand lines The cod average about ten pounds although some are taken which run as high as fifty pounds The schooners return in the autumn with holds full of salted codfish, as well as the valuable oil-bearing livers Less mechanized than any other major fishing industry in the North Pacific, codfishing on the rough and foggy outer banks is one of the more difficult occupations.

Other Table Fish. Among the other types of fish caught in some quantity and common in Northwest markets, either seasonally or throughout the year, are bottom fish, such as flounders or sole, red and ling cod, rockfish, perch, and trout. The Columbia River and other coastal streams of Oregon have a shad run each spring, and a few carloads of shad and shad roe are shipped East Columbia River sturgeon, also heavily fished for their roe, are now growing scarce. The spring run of silvery smelt in the Cowlitz River of Washington is welcomed both by commercial fishermen and by thousands who dip them up for food or sport. A large deep-water fish now caught in quantity is the sablefish, formerly called the Alaska black cod, with its fine flavor and rich meat it is becoming a favorite on the Coast

Whaling. Whaling as an industry has long since disappeared from the North Atlantic, but is still pursued along the British Columbia and Alaskan coasts, in Bering Sea, and in Bristol Bay. Two small whaling fleets, one from Victoria, B C, the other out of Seattle, still operate in the North Pacific each summer, going up in April or May and returning in September. The Canadians run a summer station on the Queen Charlotte Islands, the American whalers have their base at

Unimak Pass in the Aleutians. Small killer boats with harpoon guns hunt these northern waters for the sperm, finback, humpback, and sulphur whales. The carcasses of the great mammals are towed to shore stations for reduction, the oil is tried out, whale beef canned for sale to the Orient, and various types of feeds and fertilizers prepared for market.

The take of the combined fleet is 500 to 600 whales annually. The whale population is still diminishing, however, and unless the various whaling nations sign an international agreement regulating the industry these mammals may vanish entirely.

Fur Seals of the Pribilof Islands. The Alaska seal (really a sea lion) forms the basis for a unique fur industry. In winter the fur seals swim far south in the ocean, returning north in spring to their rookeries in the Pribilof Islands of the Bering Sea, where the pups are born. For many years skins sold at high prices, and from 1880 to 1911 seal hunters of all nations indulged in indiscriminate killing. Fearing that the herd would be entirely exterminated, the United States in 1911 negotiated a treaty with Great Britain, Russia, and Japan, prohibiting pelagic sealing The treaty came just in time, the herd having been reduced from millions to a scant 150,000

Under United States protection and management the Pribilof seals have increased over 1,000 per cent in thirty years. Coast Guard cutters protect the herd on its northward journey. Since fur seals are polygamous and the sexes are born in equal numbers, a large proportion of the bachelor seals are surplus males and can be taken each year without injury to the natural increase of the herd. Three-year-old bachelors have prime fur and furnish the bulk of the 55,000 skins taken annually The carcasses are made into meal and oil and some are fed to blue foxes, which supply about 2,000 skins per year. Altogether the "take" is worth about $1,500,000 annually, the other signatory nations sharing in the profits. Under this sensible system the seal herd now numbers over 2,000,000.

Unfortunately in 1940 Japan notified the United States that the treaty would be denounced at its expiration in 1941, claiming that the seals injured Japan's fisheries. The future effect on the seal herds will probably not be known for some time

Reduction Plants One of the most interesting trends in Northwest fisheries is the rise in reduction plants turning out oils, fish meal, and fertilizers, as well as many special products. Formerly a sideline, fish reduction is in fair way to become one of the most profitable phases of the business, particularly since it can use many varieties of inedible fish as well as the scraps left over from canning and other

processing operations. Astoria and vicinity have several plants of this type Columbia River boats in particular have been making profitable hauls of shark, taken either on hook and line or by means of harpoons like those used in whaling. Shark-liver oil with its high vitamin content is in demand by drug houses, and many fishermen are making more money taking sharks off season than by their regular catches of cannery fish. Dogfish livers, also rich in vitamins, are processed in Seattle, Tacoma, and Anacortes In this increased attention to by-products the fishing industry is beginning to imitate the meat-packing industry, which finds a use for everything which enters the packing plant.

RESTORATION PROGRAM

Protection for All Northwest Fisheries. Since fisheries play such a large part in the economy of the Northwest, public interest demands that they be preserved unimpaired as a permanent regional resource. Many years of effort have finally culminated in programs of rehabilitation for salmon and halibut. Equal care is needed for many other valuable food fish, now plentiful in North Pacific waters, but in danger of overexploitation, usually by too-efficient methods. Herring, pilchard, sturgeon, whales, shrimp, crabs, razor clams, to mention only a few, already show varying degrees of depletion.

The life history of each variety of fish differs to such an extent and the pressure upon them is so diverse that it is impossible to apply identical conservation measures to all. Each fishery must be regarded as a separate problem The remedial measures for all fisheries, however, tend to have certain similarities, which may include:

1 A program of scientific research until the complete life history is known

2 Flexible regulations which may include one or more of the following measures:

- *a* A quantity limit on the catch
- *b.* A closed season for part of the year, or possibly for a term of years, if the stock is badly depleted.
- *c.* Refuge zones or nursery areas where fishing is prohibited.
- *d* Restrictions on the size or the age of the catch.
- *e* Restrictions on type of gear

3. Legislation against stream and coastal pollution.

4 Increasing the young stock by means of hatcheries, if practicable

5 Securing the co-operation of the fishing industry and the public by a program of education

As it is always easier to preserve an original stock than to rebuild an exhausted one, fisheries experts now try to act before the latter stage

is reached. Preservation of the Northwest fisheries depends largely upon public willingness to recognize the danger, grant adequate appropriations for research, and submit to reasonable regulation The ultimate goal of all such measures is a sustained yield and a permanent abundance.

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CHAPTER 10

WATER RESOURCES RIVERS AND THEIR FUNCTION IN THE PACIFIC NORTHWEST

By ALBERT L SEEMAN

The rivers of the Pacific Northwest assumed a very real importance in the exploration of the region, as they were routes of travel by boat and canoe Even where the rivers were not navigable, the early traveler was obliged to follow the course of the rivers to meet the Indians with whom he traded for provisions or furs, and on the east side of the Cascades to obtain fuel.

Lewis and Clark, after crossing the continental divide, reached the southern fork of the Clearwater River. Very shortly after that, they constructed canoes and continued their journey.[1] This navigation was found more satisfactory and easier than traveling by foot. At the present site of the town of The Dalles they found in one of the Indian houses "a British musket, a cutlas, and several brass kettles."[2] At another place, the expedition recites that the Indians had been demoralized by the white traders with whom they had come in contact,[3] showing that the traders who had come into the country from the west had likewise used the rivers Many other and similar illustrations could be given to show the same influence of the rivers throughout all early history.

Thus the rivers have been the focal point in the historical development of the Pacific Northwest, and they are the foci of a large part of the present-day development in the region This is particularly true in the arid parts where the rivers assume greater significance than in the more humid areas Furthermore, most of the rivers of the Pacific Northwest carry large volumes of water to the sea, making them well adapted to the production of hydroelectric power.

As the area became populated and developed, the streams and rivers assumed greater significance The various rivers and streams are shown

[1] *History of the Expedition under the Command of Lewis and Clark,* edited by Elliott Coues, 4 vols., New York, F P Harper, 1893 II, 551.

[2] *Ibid* , II, 673

[3] *Ibid* , II, 693

on the map, Fig 69 The waters were used for irrigating more and more tracts of land and for the development of electric power There was a relative decline in water transportation, and flood control became a larger issue as the land was needed for settlements Each of these phases —irrigation, hydroelectrification, canalization, and flood control—will be discussed in the succeeding sections.

IRRIGATION

Irrigation is essential to habitation of large sections of the Region, and no factor has played so great a role in the economic development of the dry areas as irrigation In climate, topography, soils, and other physical features, the Pacific Northwest exhibits a wide diversity These topics have been discussed in separate chapters and should be reviewed in connection with irrigation.

Rivers

In the Pacific Northwest, the Columbia River system is of greatest significance for irrigation, as well as other uses This river drains an area of 259,000 square miles, including portions of seven states and the Province of British Columbia.

The Columbia River rises in eastern British Columbia in forested mountains and receives the drainage from nearly 40,000 square miles before entering northeastern Washington (see Fig 69) Near the Canadian-American border it is joined by Clark Fork In the southern part of Washington the Snake River enters from the east, and near Portland is the confluence with the Willamette River. Many other streams of considerable size flow into the Columbia, as the Yakima, Walla Walla, Spokane, and Wenatchee, and are available for irrigation of adjoining land The entire drainage system of the Columbia includes twenty-six principal tributaries. However, some of these streams have so deeply entrenched themselves that the adjoining lands have not been reclaimed for they cannot be irrigated by gravity and the cost of pumping is prohibitive. Along some of the other tributaries, the land is irrigated to the limit of the water supply, this is especially true of the Yakima River.

A volume of water averaging annually 151,000,000 acre-feet passes The Dalles, Oregon, and future diversion of water for irrigation will not lessen the discharge in any marked degree. This does not imply that the reclamation of arid lands above The Dalles has reached its maximum development, but rather that the quantities of water diverted for such purposes in the future will be small as compared with the total discharge of the river. In fact, the amount of the irrigable

land is about three or four times that of the irrigated land. Should the maximum of land be irrigated, and the water for irrigation become scarce, improvements of three types could be made. They are (*a*) water storage and regulation, (*b*) prevention of canal and other losses, and (*c*) more economical use of water on the land.

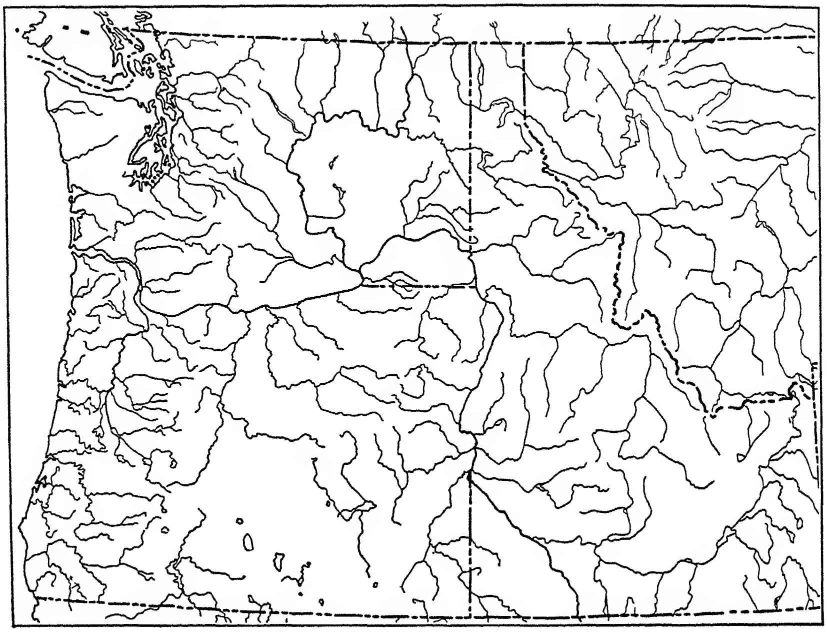

FIG. 69. Major rivers of the Pacific Northwest

History

Irrigation development of the Columbia River basin has been in progress for about sixty years and has resulted in the reclamation of nearly three million acres, the greater part of which is in southern Idaho. According to some authorities, irrigation was practiced to a very limited extent by the Indians prior to the coming of the white man into this region. In 1884, when the Northern Pacific Railroad was built through Union Gap, Washington, an old ditch was destroyed which was the property of the Indians. "There were old canals and fruit trees below Union Gap that, according to the Indians, were planted and irrigated from the Yakima River before the treaty of 1855."[4] At other places the Indians had taken advantage of subirriga-

[4] Senate Executive Document, Vol. 5, 2nd Session, 63rd Congress, p. 112.

tion as the means best suited to the growing of their corn. A few of the early trading posts used the methods of the Indians to furnish their fields and gardens with the much-needed moisture. On the small patches the early whites, and the Indians before them, raised corn, potatoes, melons, and a few other crops by subirrigating the ground.

The first real irrigation was inaugurated by the early missionaries. Their methods were crude and the areas small, but their efforts were successful; and year by year the acreage increased. Wherever water was not too difficult to put on the land, small settlements developed and re-

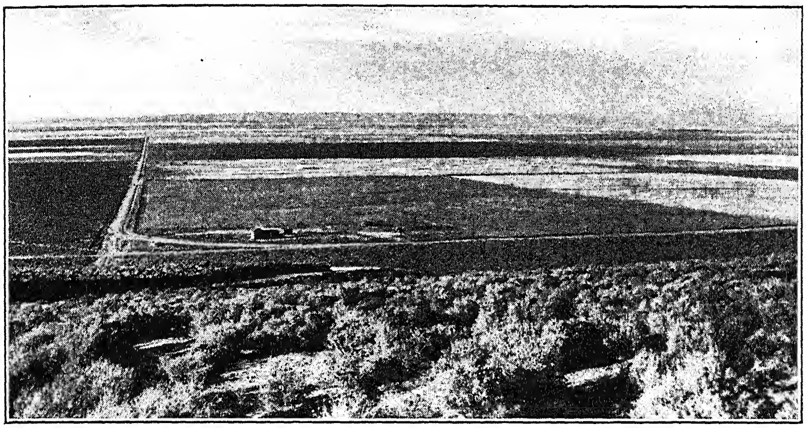

FIG. 70. Land that will be irrigated by the Columbia Basin Project in eastern Washington. In foreground is non-irrigated land covered with sagebrush. (*U.S. Bureau of Reclamation.*)

mained permanent. In places where water could be had by the flooding of the land without ditches, the settlers left few evidences of their work.

These individual enterprises were soon followed by group action, for irrigation requires unity on the part of the community. Although agriculture developed slowly, it developed steadily. The ditches constructed by community action were constructed slowly and were relatively small for these settlers did not have much capital. Nevertheless, these community ditches were constructed in various places throughout the area. After 1870, the influx of settlers was rapid, and after 1880 the completion of railroads into the Region led to enlargement of the small ditches and considerable tracts were irrigated. Later, throughout the entire West, agitation began for the federal government to take a part in the irrigation of that half of the nation.

The difference between the arid and semiarid lands and those humid

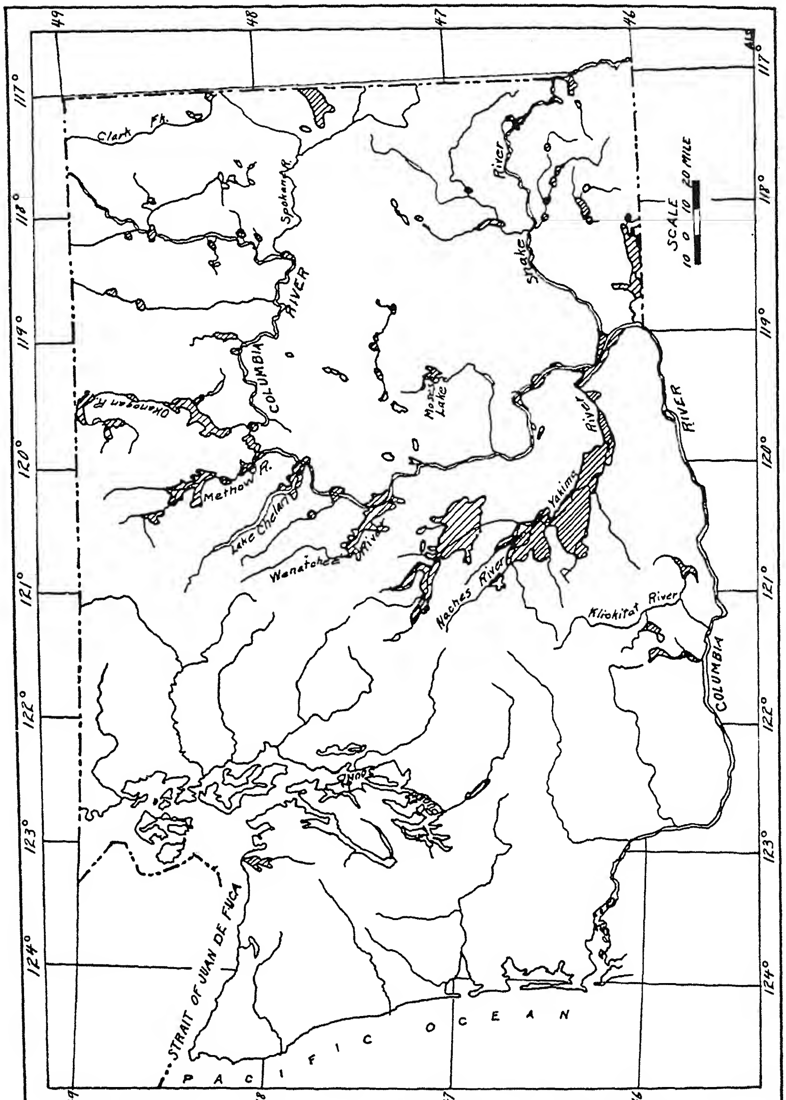

Fig. 71. Irrigated land in Washington.

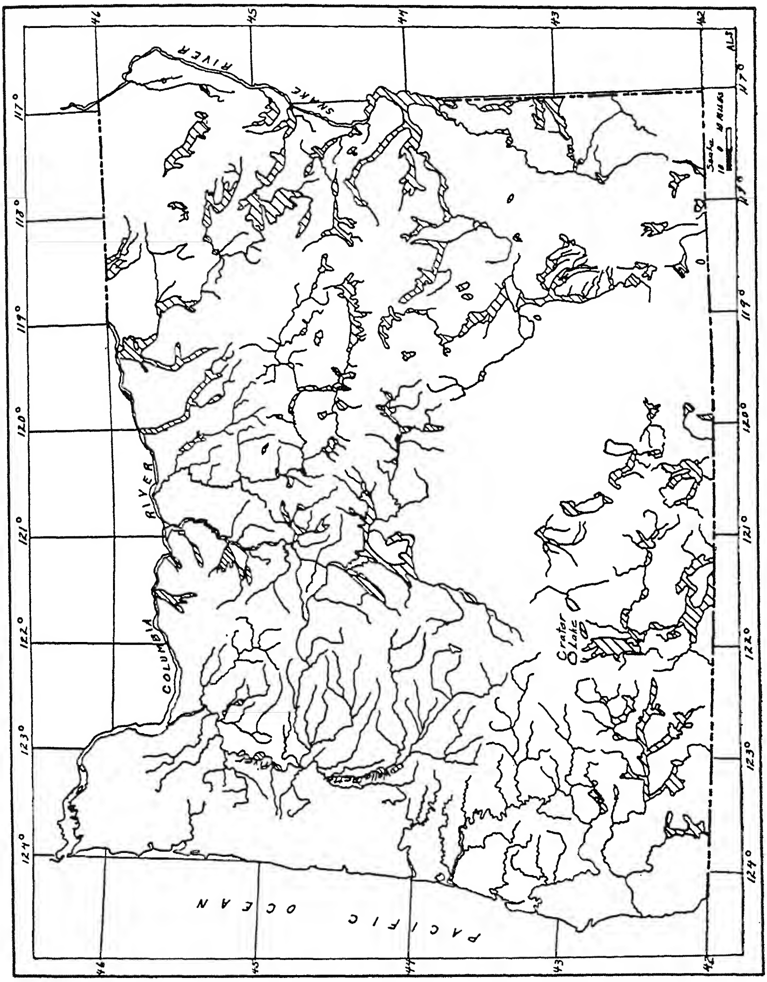

FIG. 72. Irrigated land in Oregon.

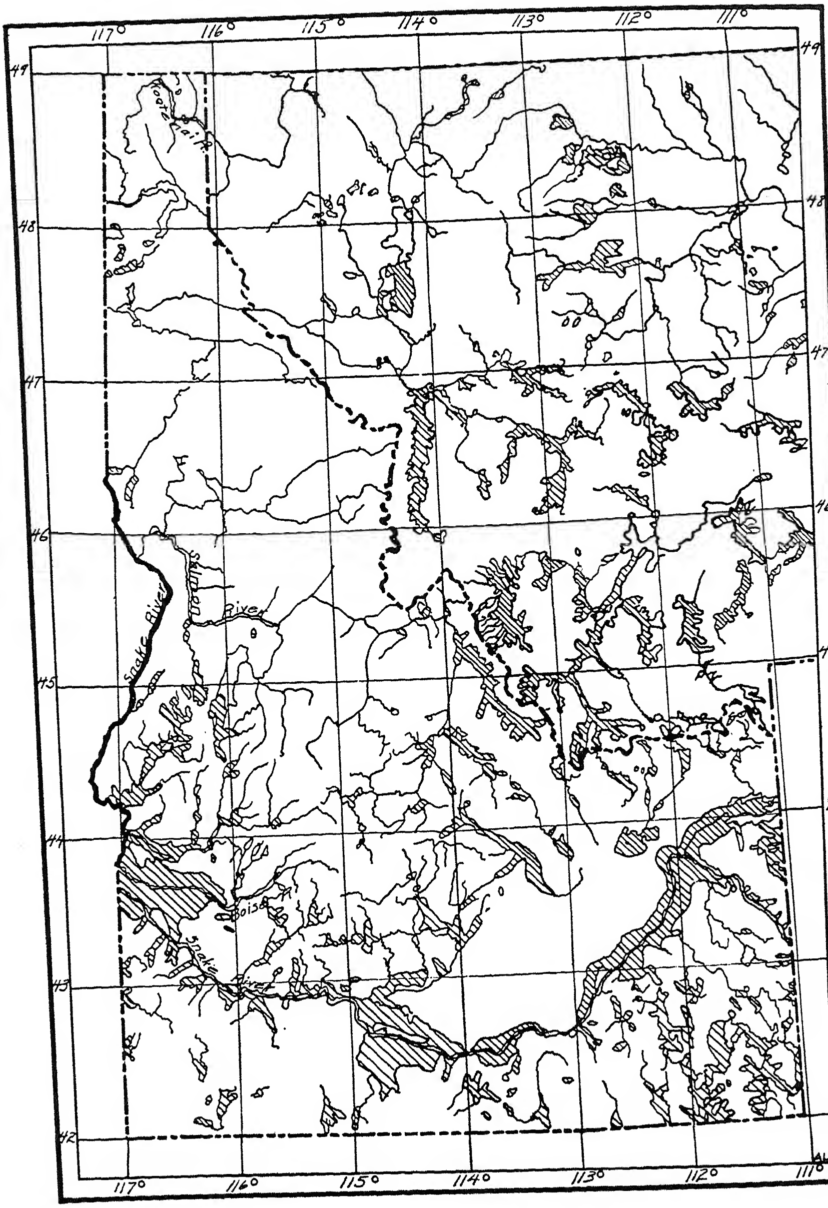

FIG. 73. Irrigated land in Idaho and Western Montana.

regions, which previously had been settled by the American people, was not reflected in national policy for many decades Although it was recognized early that irrigation must play an important role in the agriculture of the West, the Homestead Laws which had served well in the humid regions remained in effect It was not until 1902, when the Federal Reclamation Act was adopted, that the United States began to modify its policy to fit the conditions encountered in the West After the Reclamation Act was put into effect, the Pacific Northwest began to develop its agriculture more rapidly and on a more extensive scale After the legal machinery was organized, this Region received almost immediate assistance and federal projects were started It is impossible in this short discussion to cite the contributions of individuals, the state, and the federal government to the various projects now in operation or proposed Since lack of space precludes detailed descriptions of irrigated areas, the location and approximate extent of the irrigable land in the various projects now in operation are shown on the state maps, Figs 71, 72, and 73 Little projects incidental to stock-watering operations and for small gardening or patch farming are not included. Tables 8 and 9 give the areal distribution of the acres irrigated, as well as those that can be irrigated, by counties for each of the states

Acreage and Crops

An analysis of Table 8 reveals that in the semiarid sections east of the Cascade Mountains irrigation is absolutely essential to successful agriculture West of the Cascades there are also numerous sections so deficient in summer rainfall as to make irrigation necessary to profitable agriculture There is no question but that the small area now irrigated on the west side will be materially increased

Table 9 includes the total acres in crops, the acreage in irrigated crops, and the returns from this production It was impossible to segregate data for western Montana from the total figures for the state, and consequently this part of the Pacific Northwest is omitted.

The costs of construction of these projects have varied from as little as \$5 00 per acre for some of the earlier bottom-land projects to as much as \$150 00 or more for some of the later developments The average costs approximate \$44 00 per acre The annual operation and maintenance costs have averaged about \$1 80 per acre, ranging from \$0 25 per acre for the cheapest gravity projects to \$20 00 per acre for the more expensive pumping projects An examination of Table 9 shows that the crop return for irrigated land will average double that of nonirrigated land. With fair crops and fair prices the area now under irrigation in the Pacific Northwest will produce crops of gross

TABLE 8

IRRIGATED AND IRRIGABLE LANDS OF THE PACIFIC NORTHWEST*

State	County	Acres Irrigated (1929)	Acres Capable of Irrigation (1930)
WASHINGTON	Adams	1,183	479,281
	Asotin	4,162	5,012
	Benton	30,406	43,916
	Chelan	36,096	36,313
	Clallam	8,960	17,607
	Columbia	2,480	2,672
	Douglas	10,166	10,061
	Ferry	1,246	2,018
	Franklin	2,606	667,253
	Garfield	775	806
	Grant	7,610	659,000
	Kittitas	45,960	63,415
	Klickitat	11,502	18,607
	Lincoln	1,430	1,695
	Okanogan	36,322	50,011
	Pend Oreille	896	2,705
	Spokane	18,239	30,245
	Stevens	3,077	3,602
	Walla Walla	18,921	20,453
	Whitman	1,913	2,083
	Yakima	256,174	299,991
	Total	499,283	2,151,511
OREGON	Baker	119,478	134,621
	Benton	171	258
	Clackamas	566	989
	Crook	35,810	44,829
	Deschutes	48,056	82,984
	Douglas	1,445	2,830
	Gilliam	1,589	1,834
	Grant	35,895	38,699
	Harney	126,496	153,832
	Hood River	22,370	28,352
	Jackson	40,213	50,448
	Jefferson	5,207	5,475
	Josephine	19,475	25,140
	Klamath	125,049	168,434
	Lake	70,417	94,317
	Lane	1,104	2,719
	Malheur	93,008	145,757
	Marion	1,475	1,938
	Morrow	11,898	15,865
	Polk	635	775
	Umatilla	39,968	49,550
	Union	38,379	40,874
	Wallowa	43,146	47,642
	Wasco	9,559	11,536
	Wheeler	6,351	7,413
	Total	898,713	1,158,210
IDAHO	Ada	122,640	128,457
	Adams	20,536	24,647
	Bannock	97,726	124,832
	Bear Lake	54,625	55,930
	Bingham	163,914	209,120
	Blaine	33,731	38,449
	Boise	6,636	9,201
	Bonner	922	1,462
	Bonneville	98,569	105,164
	Butte	27,416	52,768
	Camas	7,108	10,306
	Canyon	196,449	202,474
	Caribou	14,692	16,240
	Cassia	79,374	104,494
	Clark	16,292	20,023
	Custer	39,346	61,673
	Elmore	22,183	29,015
	Franklin	52,738	56,060
	Fremont	98,273	111,103
	Gem	47,051	51,574
	Gooding	64,115	94,715
	Idaho	1,985	2,354
	Jefferson	120,151	169,081
	Jerome	110,098	127,098
	Kootenai	6,404	10,679
	Lemhi	61,278	68,989
	Lincoln	33,140	49,740
	Madison	55,723	59,762
	Minidoka	60,000	60,000
	Nez Perce	5,038	5,268
	Oneida	13,450	15,094
	Owyhee	57,608	71,275
	Payette	37,536	45,086
	Power	10,708	14,914
	Teton	39,014	45,991
	Twin Falls	244,832	294,487

* Data from United States Bureau of Census, Census of Irrigation, 1930

TABLE 8 (*Continued*)

State	County	Acres Irrigated (1929)	Acres Capable of Irrigation (1930)
	Valley	33,128	36,898
	Washington	26,039	31,754
	Total	2,181,250	2,617,021
W	Beaverhead	250,895	275,300
E	Deer Lodge	19,048	26,562
S	Flathead	3,703	7,177
T	Lake	41,237	121,502
E	Lincoln	6,960	8,302
R	Madison	96,296	111,105
N	Mineral	1,039	1,184

State	County	Acres Irrigated (1929)	Acres Capable of Irrigation (1930)
	Missoula	19,038	27,472
M	Powell	58,045	73,681
O	Ravalli	87,058	105,395
N	Sanders	9,243	17,466
T	Silver Bow	9,468	9,613
A	Granite	24,503	26,384
N			
A			
	Total	626,533	811,143

TABLE 9

DATA PERTAINING TO IRRIGATION IN PACIFIC NORTHWEST*

Acreage and Crops	States: Washington	Oregon	Idaho
1 Total area in state (acres)	42,775,040	61,188,480	53,346,560
2 Total acreage in crops	3,660,053	2,861,467	3,182,767
3 Percentage of items 1 and 2	8 6	4 7	5 8
4 Total acreage in irrigated crops	405,027	637,967	1,634,321
5 Percentage of items 1 and 4	0 9	1 4	3 6
6 Percentage of items 2 and 4	11 0	22 3	51 3
7 Total value all crops (000's)	144,836	89,353	104,045
8 Total value irrigated crops	61,145	24,800	73,839
9 Percentage of items 7 and 8	42 2	27 7	70 9
10 Acres capable of irrigation	2,151,511	1,158,210	2,617,021
11 Percentage of items 1 and 10	5 0	1 8	4 9

* Data from United States Bureau of Census, Census of Irrigation, 1930.

annual value of $160,000,000 or about $45.00 per acre. In sections where a considerable fruit and vegetable acreage is included, this figure has been greatly exceeded in some years in the past

Columbia Basin Project

The project of greatest areal significance is the one now under construction, namely, the Columbia Basin Project. The full significance of this project, with its 1,200,000 acres of fertile irrigable land and its major structure of the Grand Coulee Dam with a power plant of 2,500,000 horsepower, and the part that they will play in the future of the Pacific Northwest, is difficult to visualize at this time.

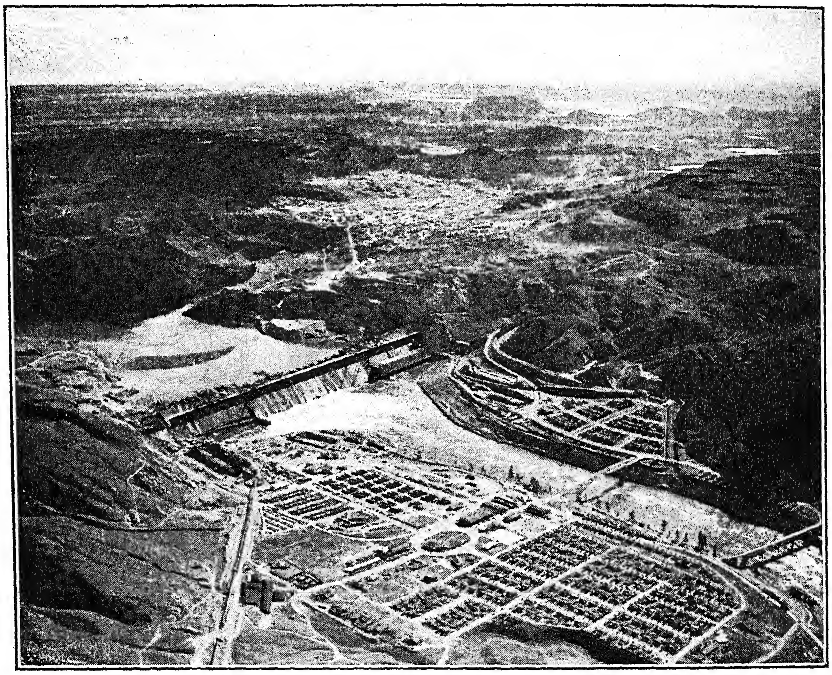

FIG. 74. Coulee Dam site from the air.

The Columbia Basin Project has several functions, all of which fit into the economic program of the future.

First, it creates a reservoir with a usable storage capacity of more than 5,000,000 acre-feet, extending from Grand Coulee to the Canadian border, a distance of 151 miles, and thereby adding a corresponding amount to the navigable inland waters of the state. Since this reservoir is located at the highest point on the Columbia River within the boundaries of the country, the waters can be released during periods of low flow to increase the channel depths of the entire river below the dam. Furthermore, it doubles the amount of firm power that can be developed at the six-power sites on the Columbia River between

Grand Coulee Dam and the mouth of the Snake River, and increases by 50 per cent the firm power that can be generated at the various sites below this point, including Bonneville.

Second, the Grand Coulee Dam and power plant will provide for the generation of 1,890,000 kilowatts of electric energy, of which 800,000 kilowatts will be firm power available for sale for commercial purposes,

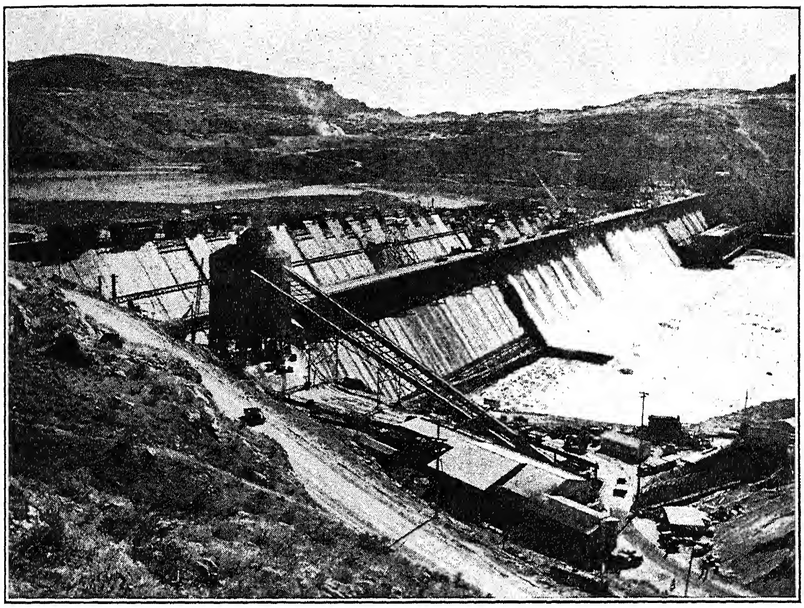

FIG. 75. Coulee Dam during construction. This is a multiple use project of special value for power and irrigation. (*U.S. Bureau of Reclamation.*)

and the remainder will be used for the pumping of irrigation water on the project.

Third, it will irrigate 1,200,000 acres of excellent land, now used only for pasture and marginal wheat farming lying between Ephrata and Pasco.

The Grand Coulee Project is essentially an irrigation project with power as an incidental, but very valuable, by-product and stream control as a substantial contribution toward the development of the rest of the river for power and navigational purposes. Out of the now barren semiarid tract, it creates agricultural land equivalent in area and productivity to three Yakima Valleys.

Since the feasibility of the project depends, in part, upon the settler

obtaining his land at its actual land value, Congress in May, 1937, passed the Anti-Speculation Act. The law requires the Secretary of the Interior to obtain an impartial appraisal of all the project lands at their present-day value without any reference to the probable availability of irrigation water in the future Any land which is to receive water, under this law, either must be sold at this appraised value of dry land, or its owner must pay a penalty of approximately half of the entire amount paid in excess of the appraisal, otherwise water will be withheld. The act limits ownership by a private individual to 40 irrigable acres of land and by a man and wife to 80 irrigable acres, it requires landowners to agree to sell holdings over this limit at a fair government-appraised price, and it denies water to holdings over this limit. Careful soil surveys are being made, town sites are being selected and planned, and roads are being laid out so that the settlement of the Columbia Basin may be efficiently accomplished

WATER POWER

The Pacific Northwest has the greatest potential water power of any region of the United States and is rapidly increasing its proportion of the developed power of the country. The United States Geological Survey reports that this Region has about 40 7 per cent of the potential water power of this nation, and the Federal Power Commission, in its annual report, credits this Region with 18.5 per cent of the developed power in January, 1940[5] The developed power is increasing in rather large blocks in the Pacific Northwest, and there is possibility of much greater production

The factors which account for the large percentage of potential water power in the region include the following (*a*) The area has swift-flowing streams due to marked topographic contrasts Such streams have high potentialities for power development. (*b*) The western side of the Cascade Mountains has abundant precipitation especially in the higher elevations (see Chapter 4). (*c*) The natural reservoirs, such as snowfields, glaciers, and lakes, help maintain a steady flow in the rivers and thereby make ideal power streams (*d*) Favorable sites in narrow sections of important valleys have impervious bedrock on which to construct dams that can create large reservoirs and supply water under a high head to develop great quantities of power.

Multiple-purpose Projects Since 1902, when the federal government

[5] U S Department of the Interior, Geological Survey, "Potential Water Power in the United States," Jan 23 1935 Mimeographed

Federal Power Commission, "Production of Electric Energy in the United States," July 29, 1940 Mimeographed

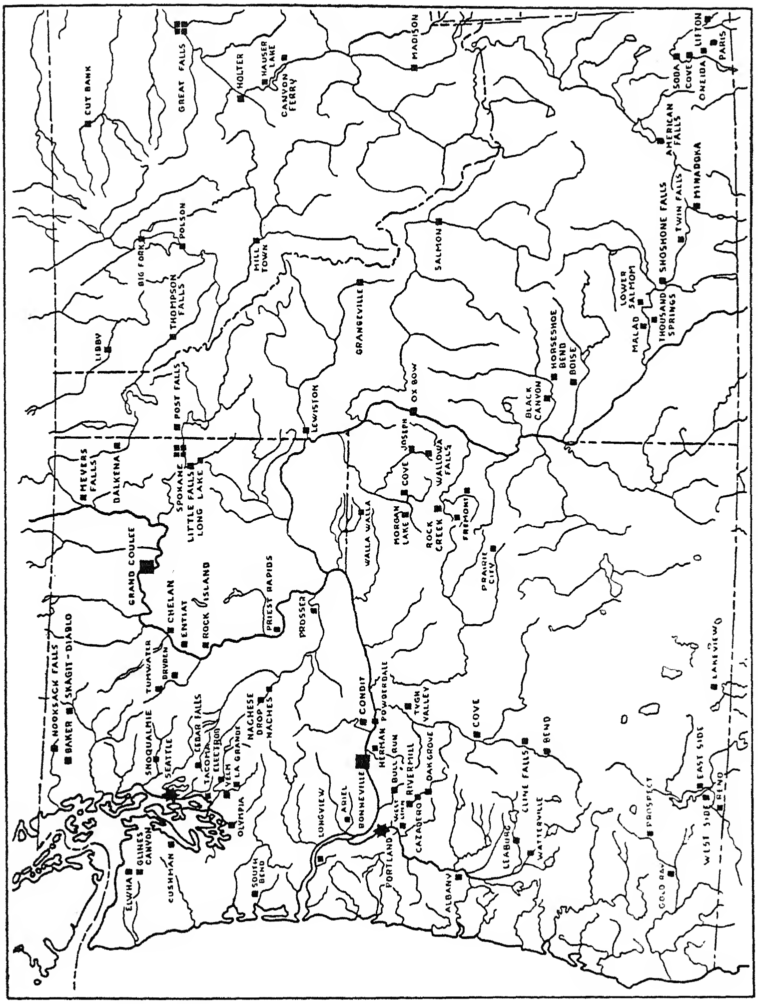

FIG. 76. Hydroelectric power plants in the Pacific Northwest.

started its program of reclamation, large storage reservoirs have been constructed for irrigation purposes. These dams and reservoirs were necessary to solve the irrigation problem, and in more recent years their function has been extended to multiple-purpose projects, including a large volume of hydroelectric power. Multiple-purpose development has been accomplished almost entirely through public enterprise for the reason that multiple-purpose projects are not inviting to private capital. All the large structures now being built by the Bureau of Reclamation are multiple-purpose dams These structures serve to (*a*) regulate streams for irrigation and domestic water supply, (*b*) control floods, (*c*) improve navigation, (*d*) generate hydroelectric power, and (*e*) abate pollution by increasing the low flow of the stream.

The locations of the major hydroelectric plants of the Pacific Northwest are shown in Fig. 76. The correlation of these plants with irrigation projects becomes apparent especially for the newer irrigated areas. The size of the plants shown on the map is given in Table 10

History In 1842, Doctor John McLoughlin used the falls of the Willamette River near Oregon City to run a sawmill and other industries for the Hudson Bay Company at Fort Vancouver. These falls were harnessed directly; nevertheless it was the beginning of the great hydroelectric development in the Pacific Northwest. In 1889, at approximately the same site, one of the earliest commercial hydroelectric power plants in the United States was built by the Willamette Falls Electric Company This power was transmitted to Portland, a distance of 14 miles, and the plant operated until 1897 The Oregon City Woolen Mills and two paper mills used in part the original water rights granted by Congress by an Act of September, 1850

The early pioneers needed lumber, flour, and grist mills These were run by water power located on small streams that could be easily developed, they were usually the first manufacturing started in new communities. Although water power was used in this manner early in the history of the Pacific Northwest, development of most water-power sites was slow throughout the Region. In large areas agriculture was the chief activity and little power was needed. In the western part of the region, lumbering was the dominant industry and developed its power with steam engines driving long lines of shafts. Sawdust and waste wood were used as fuel The electrification of sawmill machinery has taken place in recent years. As the wood pulp and paper manufacturing grew in importance in the past decade, large blocks of electric power were used.

Although water power is only one means of developing electricity, it has been in the Northwest the prime source, with steam as a standby

TABLE 10

CAPACITY OF HYDROELECTRIC PLANTS IN PACIFIC NORTHWEST

Plant	Capacity (kilowatts)	Plant	Capacity (kilowatts)
WASHINGTON		Bend	1,000
Ariel	43,000	Bonneville	504,000
Baker	40,000	Bull Run	21,000
Cedar Falls No 1	40,000	Cazadero	15,250
Cedar Falls No 2	13,750	Cline Falls	200
Chelan	48,000	Cove No. 1	300
Condit	15,000	Cove No 2	1,200
Cushman No 1	32,000	East Side	4,000
Cushman No 2	54,000	Fremont	1,100
Diablo	20,000	Gold Ray	1,500
Dryden	2,450	Joseph	1,000
Electron	22,500	Lake View	250
Elwha	12,000	Leaburg	7,300
Entiat	1,100	Morgan Lake	380
Glines Canyon	12,000	Oak Grove	38,000
Grand Coulee	1,890,000	Powderdale	6,000
Gorge	85,500	Prairie City	680
Jim Creek	200	Prospect	42,960
Kalama	600	Reno	900
LaGrande	24,000	Rivermill	14,050
Lake Sylvia	200	Rock Creek	800
Leavenworth	130	Sherman	220
Little Falls	29,500	South Baker	1,000
Long Lake	70,000	Tygh	1,890
McCoy Creek	140	Walla Walla River	2,250
Naches	5,400	Wallowa Falls	900
Naches Drop	1,300	Waterville	3,200
Newhalen	2,000	West Linn	5,430
Nine Mile	12,000	West Side	500
Nooksack	1,750	Winchester	900
Olympia	1,650		
Pilchuck Creek	100	IDAHO	
Priest Rapids	1,800	American Falls	27,400
Prosser	3,000	Ashton	5,000
Rock Island	60,000	Black Canyon	8,000
Seattle	1,500	Boise	2,200
Snoqualmie	11,250	Cove	7,500
South Bend	240	Grace	44,000
Spokane (2 plants)	17,200	Grangeville	620
Umwater	5,500	Hailey (2 plants)	1,000
White River	60,000	High Creek	130
Yelm	4,000	Horseshoe Bend	1,500
		Idaho Falls	1,200
OREGON		Lewiston	10,000
Albany	800	Lifton	4,500
Astoria	5,000	Lower Am Falls	10,000

TABLE 10 (*Continued*)

CAPACITY OF HYDROELECTRIC PLANTS IN PACIFIC NORTHWEST

Plant	Capacity (kilowatts)	Plant	Capacity (kilowatts)
Lower Salmon	6,500	WESTERN MONTANA	
Malad	5,500	Big Fork	4,150
Oxbow	2,000	Canyon Ferry	11,420
Paris	650	Cut Bank	020
Post Falls	11,250	Great Falls (4 plants)	158,000
St Anthony	500	Hauser Lake	18,000
Shoshone Falls	10,600	Holter	50,000
Soda	14,000	Libby	190
Swan Falls	9,900	Madison	9,000
Thousand Springs	8,500	Milltown	3,400
		Polson	150,000

Source United States Engineers Office

for peaks and periods of low water. With the development of the market for electricity, sites with larger capacities were utilized and reservoirs were constructed to regulate the stream flow.

The larger percentage of the hydroelectric power of this region is used for residential purposes, approximately 20 per cent as against 13 per cent for the entire nation. The large proportion of residential

TABLE 11

PRODUCTION OF ELECTRIC ENERGY IN PACIFIC NORTHWEST*

(in millions of kilowatt-hours)

Year	Total	Washington	Oregon	Idaho
1927	3,775	2,124	845	806
1928	4,350	2,361	1,040	949
1929	4,508	2,552	1,160	896
1930	4,684	2,554	1,220	910
1931	4,546	2,572	1,177	797
1932	4,039	2,486	968	585
1933	3,998	2,438	964	596
1934	4,436	2,747	1,003	686
1935	4,740	2,983	1,084	673
1936	5,323	3,272	1,253	798
1937	6,093	3,729	1,392	972
1938	5,638	3,393	1,253	992
1939	6,028	3,444	1,459	1,125

* Sources 1927 1928, United States Engineers Office, Seattle, 1929–1937, C E Magnusson, "Electric Power Markets in Washington," *Bulletin* 99, 1938–1939, Federal Power Commission Data for Western Montana not available

consumers has had a stabilizing effect on electric utilities Industrial loads are more subject to periods of depression. The residential market can be greatly expanded and the trends, especially in the Pacific Northwest, are well defined for this expansion.

Development of Electric Power Table 11 shows the changes which have taken place in the three states since 1927 During the decade ending with 1930, the requirements for power in the Pacific Northwest increased at an average rate of 9 5 per cent per year compounded annually The effect of the depression was to suspend for about three years the normal growth in power consumption Power fell a little between 1930 and 1933, during 1934 it returned to the 1930 maximum and then resumed its former rate of increase This rapid increase took place without any marked growth in industrial development Only since about 1939 has there been any increase in the number or capacity of industries

The Bonneville and Grand Coulee projects, which together form the largest power pool in the nation, were linked by a 230,000-volt power line, 235 miles long, in August, 1940 The projects ultimately will have capacity to produce 2,300,444 kilowatts of power The entire Columbia River industrial area is now within reach of two of the greatest power plants in the country In addition, Bonneville project has signed contracts with many public utility districts for power as far north as Tacoma and Seattle Revenues for 1940 for Bonneville Power Administration will approximate one million dollars, and present contracts will double this amount for 1941

The new industries which came to the Pacific Northwest in 1940, owing to the availability of low-cost Columbia River power, include the Aluminum Company of America at Vancouver, Washington, to produce pig aluminum, the Pacific Carbide and Alloys Company to manufacture calcium carbide; and the Sierra Iron Company to produce pig iron The Bonneville Power Administrator has contracted, or is making arrangements to contract, other electrochemical and electrometallurgical industries. Part of this increase in the number of industries is due to war stimulus in 1940, and part may be due to low cost of power and the proximity of many minerals in the western states.

Among the interesting features of hydroelectric development in the Pacific Northwest are the various municipalities which own their own power projects The City Light Company is an example Construction, started by the City of Seattle in 1919 on the Skagit River, has been increased steadily In 1940 it had a capacity of more than 438 million kilowatt-hours. The Tacoma Light Company, another municipal-owned plant, has the lowest residential electric rate of any company in

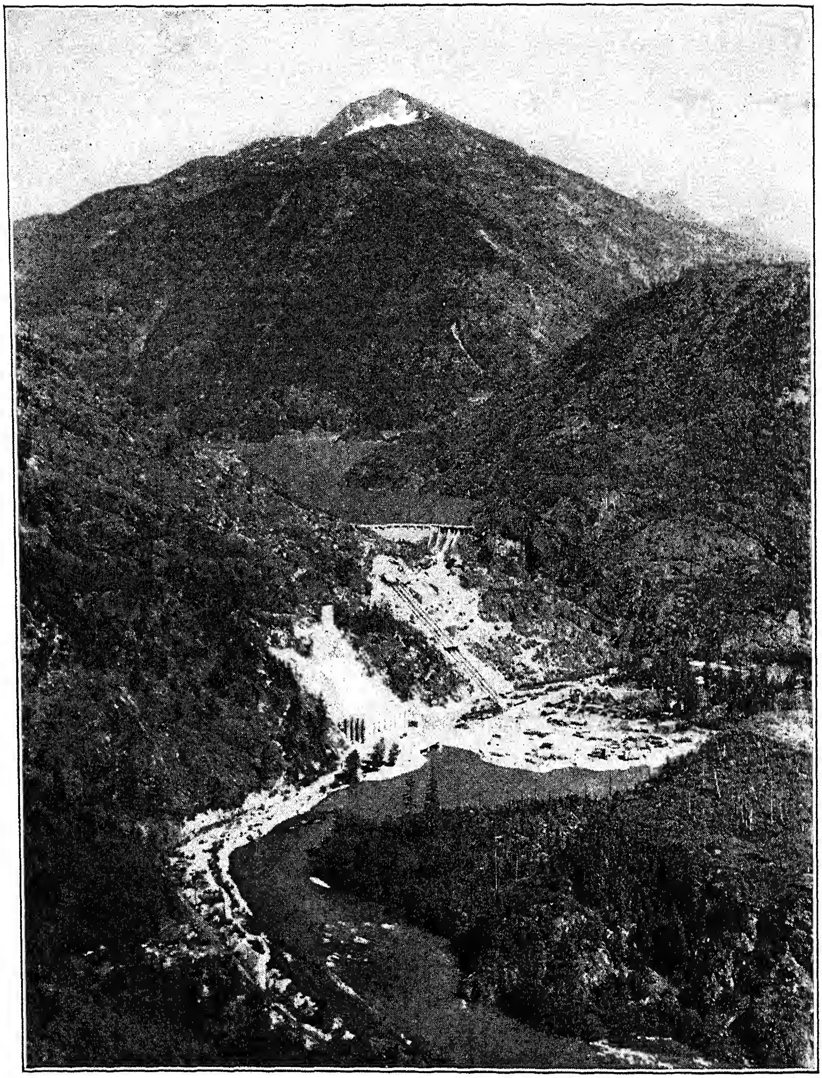

FIG. 77. Seattle City Light hydroelectric plant on Skagit River. (*Courtesy Seattle City Light Co.*)

the United States[6] Many other municipalities own hydroelectric plants within the Region

FLOOD CONTROL

Rivers, in addition to being a resource, may at times and in some places create a serious problem when they leave their banks and flood the adjoining area In the Pacific Northwest the flood menace is relatively not serious East of the Cascade Mountains, the rivers flow in well-defined and deep channels with only occasional places where there are low lands subject to overflow Since the area of these low lands is small, the problem of flood protection is wholly local In other places, east of the Cascades, floods may follow so-called cloudbursts The damage in these areas may be considerable, but, viewed in proportion to the large area, are not a serious problem

West of the Cascade Mountains a combination of various elements may produce serious flood problems The stream channels change abruptly from steep gradients and gorgelike stream beds to those which are shallow and meandering In the higher elevations, precipitation occurs in the form of snow Sudden melting of the snow caused by Chinook or Foehn winds, accompanied by rain, causes excessive water to accumulate in the higher streams This excessive water comes usually in the winter when the highest tides prevail and prevent the water from reaching the sea This combination of excessive melting of the snows, the shallow stream beds, and high tides produces serious floods in both western Oregon and western Washington Although the areas involved are comparatively small, the damage in the area flooded is considerable. Especially vulnerable areas are found in many cities and towns through which channel capacities are inadequate to carry flood waters, and floods of great destructive force may occur In the less densely populated areas, farmlands may be inundated and ruined, crops and highways destroyed, and there may be other destruction as well

Under the Flood Control Act, approved June 22, 1936, the United States Government through the Corps of Engineers, United States Army, initiated a comprehensive study of the flood-control problem of the Pacific Northwest Preliminary examinations and surveys in the interest of flood control on nearly all the rivers of this area were made, and the results of these studies were submitted to Congress with appropriate recommendations All possible means of obtaining flood control

[6] Federal Power Commission, *Electric Rates in the United States*, July, 1940 Mimeographed

were embraced in the reports, both in local areas and generally throughout the watersheds.

The flood-control measures which are applicable to the Pacific Northwest include: levees, channel improvements and stabilization, diversion, reservoirs, removal of people from areas likely to be flooded and controlling such areas, and reforestation and soil management.

FIG. 78. Flood waters over highway in Snohomish Valley, western Washington. (*Courtesy Margaret Hoem.*)

The United States Engineers, in carrying out these plans, include two or more of these measures for each of the various projects.

The projects which are being constructed, and which have been approved for construction, are shown on the accompanying map, Fig. 79.

One of the largest projects of flood control in the Pacific Northwest is in the Willamette Valley. The project is designed to regulate the flow of the river to eliminate the problem of excessively high or low water. The first of the seven dams is constructed northwest of Eugene in the flat prairie known as Fern Ridge. The cost of this dam is $2,600,000; the cost of the total project will amount to $62,000,000.

At more or less regular intervals, a combination of "Chinook" winds and heavy rainfall or wet snowfall, quickly melting the winter snow, raises levels in the tributaries and the Willamette. At Eugene, a 14-foot flood stage was recorded in 1937. Lesser stages, although they

apparently do little damage since larger communities are not affected, destroy valuable farm property all along the river every year

Smallest damage occurs when the accumulation of winter moisture is stored naturally in the hills, the snow melting slowly during the winter and summer, and the flow of the river increasing only gradu-

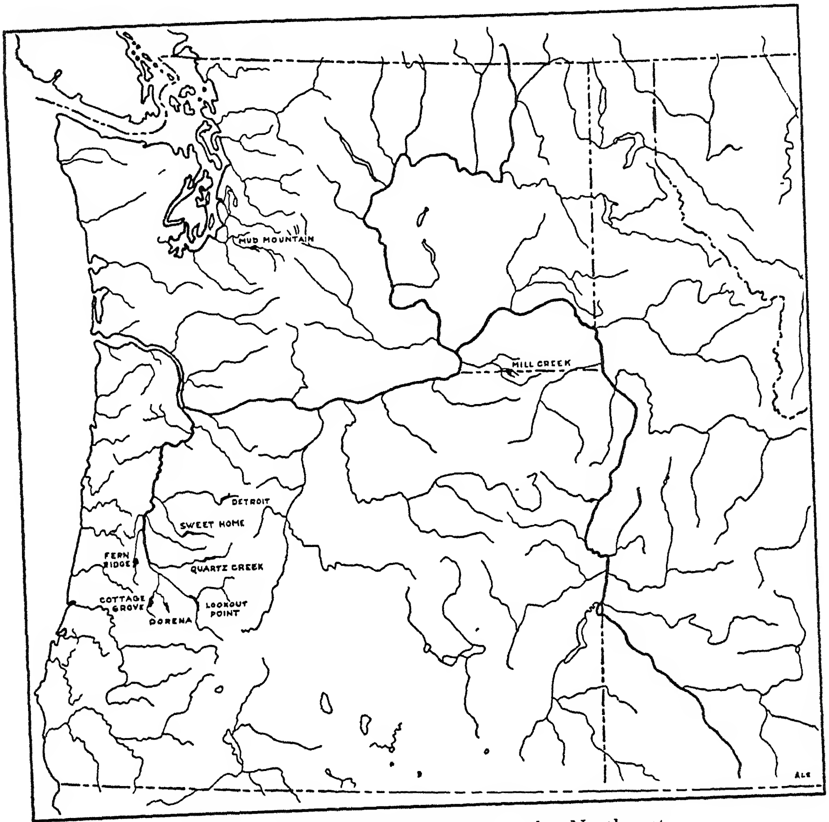

FIG 79 Flood-control projects in the Northwest.

ally. The plan of the United States Engineers is to store winter moisture, by installing in the river system seven dams and basins which will serve as gigantic "valves." These basins will enable the engineers to regulate the flow of the river. The storage reservoirs, when completed, will hold back more than 400,000,000,000 gallons of flood waters.

The second dam, started early in July, 1940, is located six miles south of Cottage Grove on the coast fork of the Willamette Behind the dam, a lake one mile wide and three miles long will be formed.

The dam, which is 100 feet above the river level, is an earth-filled construction with concrete spillway. The five other dams will be located, according to plans in 1940, in the Cascade Mountain area.

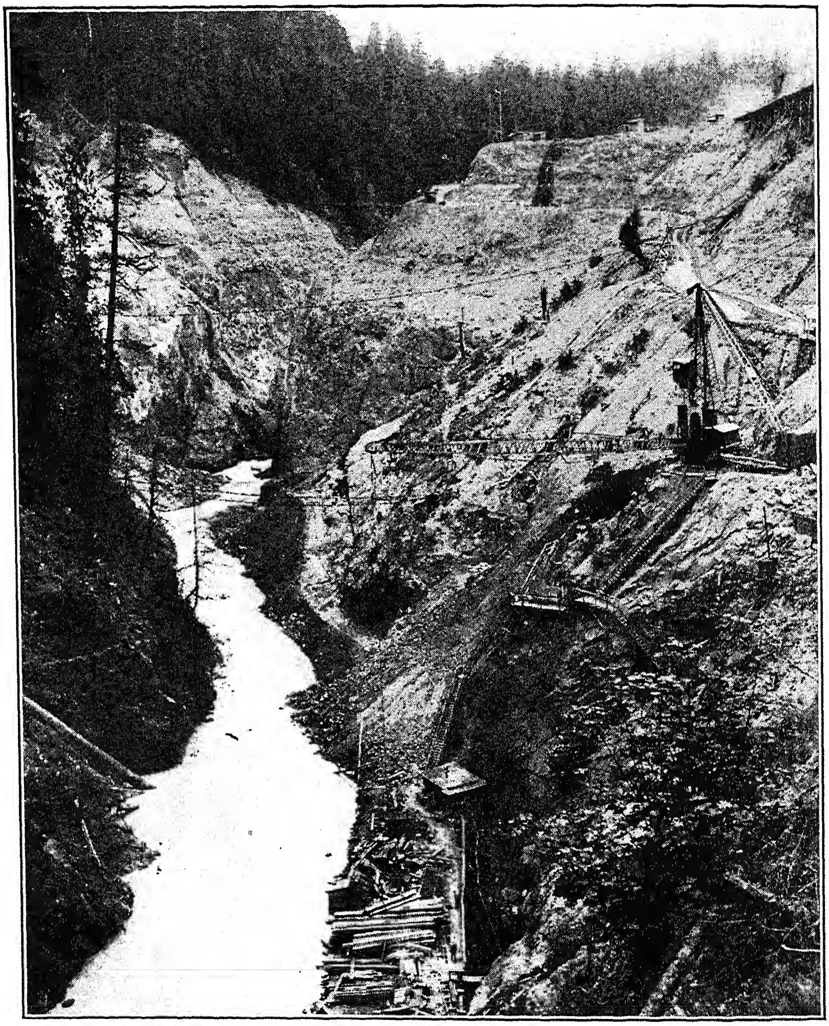

FIG. 80. Construction at Mud Mountain Dam, a flood-control project. (*U.S. Army Engineers, Seattle District.*)

Funds for development of the Willamette River were allotted by Congress. The project, when completed, will include development of navigation facilities on the river between Portland and Eugene and will provide additional facilities for irrigation and hydroelectric power.

NAVIGATION

Inland navigation in the Region is mostly concerned with the Columbia and its larger tributaries. After the discovery of the river by Captain Gray on May 11, 1792, the stream was followed to the sea from the confluence with the Snake by the Lewis and Clark Expedition. The first white persons to navigate the upper Columbia River were members of the Northwest Fur Company under David Thompson. They started from Canada in 1810, and, after wintering along its headwaters, reached the mouth of the river the following summer.[7] The early settlers to the Pacific Northwest came primarily by overland route, but the farms were located near the rivers to carry their surplus goods to market.

The first steamship to navigate the river was the Hudson Bay Company's steamer *Beaver* in 1836; this steamer was also the first on the Pacific Ocean. It was not until 1850 that an American steamer entered the river Only vessels of less than 20-foot draft could navigate the river entrance in its unimproved condition These vessels could navigate as far as St. Helens, Oregon; lightening of cargoes at that point was frequently necessary to carry the 20-foot draft to Vancouver, Washington, and Portland, Oregon. The fact that Vancouver was the head of navigation was a factor in locating the Hudson Bay headquarters there in 1821 Vancouver, about 104 miles from the mouth of the river, and Portland, located on the Willamette River about 6 miles above the confluence of the two streams, are still the limit for ocean-going vessels for the river has not been canalized above that point In 1850, two steamers were on regular schedule between these two cities and Astoria at the mouth of the river. The fare was $25 per passenger and $25 per ton for freight.

The Cascade Rapids, about 35 miles above Vancouver, obstructed navigation for any type of vessel Warrendale, near the rapids, became a portage point when navigation above the rapids was inaugurated. The navigation of the upper river started the latter part of the year 1851, and traffic was much increased when gold was discovered in Idaho in the 1860's[8] The portage of goods continued until 1896, when the Cascade Canal was opened to river vessels At various stretches along the river navigation was inaugurated, though at frequent places it was necessary to portage the goods around rapids until other canalization projects were completed, notably the Celilo Canal, 8½ miles long opened in 1915 Navigation above Cascade Rapids to The Dalles

[7] T C. Elliott "David Thompson, Pathfinder, and the Columbia River," *Oregon Historical Quarterly* Vol 29, 191-202

[8] *Swift Flows the River*, by Nard Jones, describes this period of navigation

ceased entirely in 1923 owing to a lack of patronage, although some log rafts were brought down the river from time to time. The railroads absorbed the traffic which formerly had been carried on the river as far inland as Lewiston, Idaho. Along the lower reaches of the river, however, a marked increase in river traffic occurred.

One of the purposes of the $33,000,000 Bonneville Dam on the

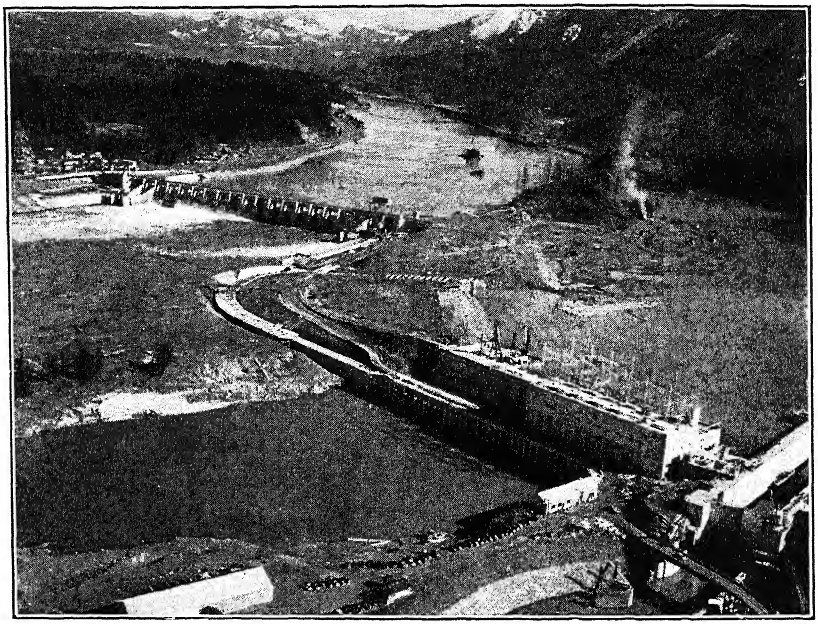

FIG. 81. Bonneville is a triple-purpose dam. It includes a large power plant, fish-ways for passage of salmon, and the largest lift lock north of Panama. (*Courtesy Bonneville Project.*)

Columbia River was to increase transportation facilities to and from eastern Oregon, eastern Washington, and western Idaho. Use of the waterway to lower Columbia River ports was started early in 1940. The navigation lock, located on the Washington side of Bonneville Dam, is the largest single-lift lock in the world; it is 76 feet wide and 500 feet long. The vertical lift at extreme low water is 66 feet. This lock, the largest north of Panama, will pass ocean-going vessels, and when the channel from Vancouver to Bonneville is improved such vessels will be able to go inland as far as The Dalles. (See Fig. 81.)

In 1940, plans were being carried forward for the construction of a 44,000-bushel elevator at Umatilla, Oregon, from which barges would

handle grain. An elevator with a capacity of 30,000 bushels was constructed in The Dalles in 1939 In 1939 it was necessary to handle all grain in sacks; now conveyor belts do the loading and unloading

Completion of the dam and locks led to the construction of a fleet of steel barges for the movement of petroleum and oil products upstream from Portland to Umatilla, Oregon, and Attalia, Washington, near Wallula The successful operation of the boats, pulled by powerful steel tugs, at a low cost caused a series of experimental grain shipments to be made to Portland on the return trips. The lower freight cost on petroleum and oil products has reduced the price of these products at inland points Pasco is encouraging the beginning of transportation to that point, and cargoes of petroleum have been delivered successfully at Lewiston, Idaho, up the Snake River Since past practice has required shipment of grain either by truck or railroad, both more expensive methods than by barge, it seems probable that use of the Columbia River will give a considerable saving in transportation costs. It is a one-step shipment to Portland by water and two-step to any port in the world, for the barge can haul alongside the ocean-going vessel at The Dalles or Portland.

Extensive canalization by the federal government is necessary to provide navigation on the Columbia River Exceptional low-water periods may occur, usually during the winter months, and for days or weeks only boats with a draft of five feet or less can operate above Vancouver. Below Vancouver, there is always sufficient water for navigation. Waters at flood stage are not serious enough to interfere with navigation. Whereas low water and high water may have been impediments in the past, with the construction of dams for power and irrigation at various points on the river, and construction of locks, both handicaps can be regulated. During some winter seasons the river is free from ice, but there is generally some ice every winter. At times, it has been filled with ice down to the mouth Above Vancouver, a delay of a month or two annually may be expected, the Cascades canal may be closed with ice even though the river itself is not entirely closed to navigation The chief obstacles to navigation are rapids and falls. These obstacles may be remedied by the construction of locks, that have been proposed as far as the confluence with the Snake River, but none yet exist above the Celilo locks (near The Dalles) at the present time. Above that point, the rapids and falls become too numerous, especially on the Columbia proper, so that it is not feasible to consider that reach as navigable for commerce at present. In the 151-mile lake

formed by Grand Coulee Dam, logs and minerals may be delivered to processing plants.

Although a great many other rivers in the Pacific Northwest have been legally defined as navigable, they cannot be considered as such in fact. Coastwise steamers may use some of them for short distances and they may be used by log rafts, but these rivers play no role in a general treatment of river navigation.

DOMESTIC WATER SUPPLY

Domestic water supply becomes an important problem in every region where there is a large community, and assumes greater importance where the number or size of the communities increases. In the Pacific Northwest, the rivers rising in the near-by mountains are free from impurities and are not contaminated by sewage from communities through which the river flows. In most other parts of the United States the cities are compelled to treat the water, chemically or otherwise, to deliver it wholesome to its consumers. This is not necessary for municipalities in the Pacific Northwest[9] The chief problem for these various governments to insure an adequate and uncontaminated water supply at a low rate is protection of the watersheds. Since those who are in authority are aware of this situation, the problem need never become serious.

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[9] Some of the large steamship companies fill their water tanks before leaving Seattle for the Orient with enough water for the entire trip

CHAPTER 11

FORESTS OF THE PACIFIC NORTHWEST

By Stephen N. Wyckoff*

IMPORTANCE AND EXTENT OF THE FORESTS AND WOOD-USING INDUSTRIES OF THE REGION

A Major Factor in the Settlement of the Pacific Northwest

The history and settlement of the Pacific Northwest is inextricably linked with its forests and the uses to which they have been put, its future prosperity will be equally dependent upon our wisdom and foresight in using them

Ever since the white man came to this region the forests have provided fuel, shelter, and a means of livelihood for much of the population. Simple logging and milling started with the first permanent settlement preceding organized government At first limited to demand for local building material, it was not long before lumber was shipped to California, the eastern states, and foreign countries. Lumber manufacture became the primary industry in an early day, a position it still maintains. Other forest uses developed, and at the present time forests contribute to the support of a major part of the population.

The character and extent of the forests, the value of their products, the number of persons employed in forest enterprises, and their influence upon local economy indicate their importance as one of the greatest natural resources of the region This importance, in fact, transcends regional boundaries, and is national in scope. The Pacific Northwest contains nearly two-thirds of the old-growth saw timber remaining in the entire country and thus constitutes a great timber storehouse for the nation If these forests are managed wisely they will always comprise a reservoir of timber upon which the nation may draw for many uses, to its general benefit and to the good of the region.

* The writer is indebted to R W Cowlin, Senior Forest Economist, and Dr J E Lodewick, Senior Silviculturist, of the Pacific Northwest Forest and Range Experiment Station for valuable assistance in the preparation of this text The Northern Rocky Mountain Forest and Range Experiment Station and the Intermountain Forest and Range Experiment Station have kindly supplied the author with many data for the Northern Rocky Mountain and the Intermountain Subregions

TABLE 12

FOREST LANDS OF THE PACIFIC NORTHWEST BY CHARACTER OF GROWTH AND SUBREGION

(Thousands of acres)

Subregion	Total Land Area	Total Forest Land Area	Commercial Forest Land Area						Non-commercial Forest Land Area
			Softwood				Hard-wood	Total	
			Little or No Reproduction (Class 1)	Young Second Growth (Class 2)	Merchantable Second Growth (Class 3)	Old-growth Forests (Class 4)			
West Coast*	35,127	29,003	4,383	6,688	3,216	10,750	753	25,790	3,213
Northern Rocky Mt †	43,515	28,609	3,573	8,743		8,905	64	21,285	7,324
Intermountain ‡	111,560	41,851	1,145	3,783	3,984	19,125	89	28,126	13,725
Total	190,202	99,463	9,101	19,214	7,200	38,780	906	75,201	24,262

* Oregon and Washington west of the Cascade summit
† North Idaho, northeastern Washington, and western Montana
‡ Remainder of Oregon and Washington, south Idaho, and northwest Wyoming.

If managed for continuous production, the forests will remain a great economic and social asset and a source of pleasure and welfare to the people. If not so managed, there is grave danger that they will become an economic liability and a social burden.

Extent of the Forest Resource

Of the 190.2 million acres of land in the Pacific Northwest, 99.5 million acres are classified as forest land, or land primarily useful for growing forests. This great forest area consists of two major parts, commercial forest land and noncommercial forest land. Commercial forest lands are those which will produce timber products of commercial value, such as sawlogs for lumber manufacture, pulpwood, fuel wood, poles and piling, and special grades of logs for plywood manufacture. Commercial forests thus occur on lands which grow timber at a reasonably rapid rate, where tree species of value occur, and which are sufficiently accessible and not too rugged to permit profitable removal of these raw products. Noncommercial forests are those which, by virtue of slow rate of forest growth, the occurrence of tree species of little value, or inaccessibility, are not suitable for commercial use. In this Region these noncommercial forests frequently occur in the higher elevations of the great mountain ranges. In this Region 75.2 million acres bear commercial forests and 24.3 million acres noncommercial forests (Table 12). Of the commercial forests, those in the West Coast Subregion (see Fig. 82) occur on 25.8 million acres, with 49.4 million acres bearing commercial forest in the Intermountain and Northern Rocky Mountain Subregions.

Direct Values of the Forest

These commercial forests are the basic resource for industries which pay 150 million dollars a year in wages and produce commodities valued at about half a billion dollars annually (Table 13). (The value for any given year depends upon the volume of production and the market prices for the products.) Each year the forests yield the equivalent of 12 billion board feet of logs for industrial use. The lumber industry produces 10 billion feet of lumber[1] annually. Employment is directly provided for 15 per cent of all those gainfully employed in the region, and in addition employment and volume of business in many service industries are greatly augmented. Commodities produced from the forests provide over 60 per cent of the railroad freight tonnage originating within the region, and represent 40 per cent of the revenue

[1] One billion board feet of lumber is sufficient to build 50,000 houses of six rooms each.

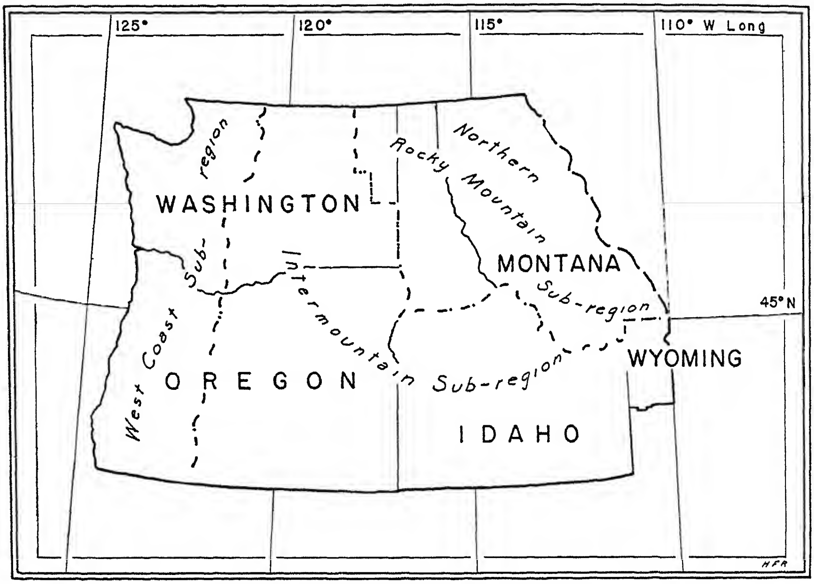

FIG 82 Forest subregions of Northwest

earned on all such tonnage Of water-borne freight exported from the region they constitute about two-thirds of the volume and about one-half of the value Another extensive use to which the forests of the

TABLE 13

AVERAGE NUMBER OF WAGE EARNERS, WAGES PAID, AND VALUE OF PRODUCTS IN PRINCIPAL FOREST AND WOOD-USING INDUSTRIES OF THE PACIFIC NORTHWEST, 1937*

Industry	Average Number of Wage Earners	Wages Paid	Value of Products
		Thousand dollars	*Thousand dollars*
Lumber and timber products†	96,203	122,520	354,559
Planing mills‡	5,635	6,482	27,509
Woodpulp	5,554	7,940	56,976
Paper	5,353	7,202	53,692
Wooden boxes	1,192	1,086	4,250
Furniture	4,066	4,312	13,396
Total	118,003	149,542	510,382

* Based on Biennial Census of Manufactures, 1937
† Includes logging camps, sawmills, and combined sawmills and planing mills
‡ Planing-mill products and other wood products not elsewhere classified made in planing mills not connected with sawmills

region are put is the provision of forage for range livestock The open character of many commercial forests in the Intermountain and Northern Rocky Mountain Subregions permits the growth of grasses, shrubs, and annual weeds which are utilized as forage by great numbers of range cattle and sheep.

These forest values are direct, in that they give profit and employment in the production, manufacture, distribution, and sale of products immediately derived from the forest.

Indirect Values of Forests

All forests, whether commercial or noncommercial, have other values often termed indirect because their benefits are not so immediately associated with industry and commerce. For this reason, these indirect values are difficult to measure in financial terms, but are nevertheless real. Forests protect the soil upon which they grow from erosion and, through lessening the silt load of streams, guard engineering works, agricultural land, and river and harbor improvements from damage. The rapid melting of snow and runoff of rain are lessened, the former by the shade afforded by the forest itself, the latter by the spongy litter on the forest floor The effect is to lengthen the period of time over which melted snow or rain will flow over the ground surface and thereby increase its opportunity to percolate into the soil Thus, floods are prevented or at least lessened, and stream flow is regulated, to the benefit of man in the valleys below.

The American people are turning in increasing numbers to the forests for recreation. Stream and lake shores are dotted with camps and picnic grounds Various organizations and even towns and cities are establishing permanent forest camps for their members and citizens Fishing and hunting bring in thousands at certain seasons. Winter sports, now so popular, are most frequently enjoyed in the higher mountains in scenes of forest beauty. The National Park Service reports an increase in the number of visitors to the national parks of the Pacific Northwest from 576,629 in 1932 to 1,369,140 in 1939. The U S. Forest Service records indicate that the number of persons using the national forests of the Pacific Northwest for recreation rose from 1,319,212 to 2,966,920 in the same period. This type of recreation is now increasing so rapidly that it is difficult to predict its future extent.

The average person, bent upon an outing in the open, will most frequently state that he is going "to the mountains" or "to the hills" However, it is obvious that were the mountains denuded they would be less attractive to him The forest is the magnet which draws the outdoor recreationist. And the use of the forests for recreation is of

great value to the people of the Pacific Northwest, not only because it brings healthful pleasure but also as a source of revenue

Millions of dollars are spent each year in the Region by those who come from elsewhere to enjoy its mountains and forests. Although the value of this tourist trade is very tangible, it is so difficult of analysis that it is generally considered one of the indirect values.

Closely associated with forest recreation is the value of the forest as a wildlife habitat. The crowds that daily watch the feeding of the bears in the national parks, the interest of most people in seeing a deer, elk, or cougar in its native haunts, the thrill of big game or bird hunting or fishing, all testify to the importance of the forest in preserving these forms of life in their native environment.

THE FOREST AS A BIOTIC ENTITY

The Nature of a Forest

Ostensibly a forest is an aggregation of trees. Actually it is a biological universe consisting not only of the trees within its borders but also of numerous other forms of plant and animal life, all forming a complex association. It contains trees, shrubs, annual plants, ferns, mosses, fungi, and a teeming world of microscopic plant life. Similarly, it includes many forms of animal life, the larger animals, birds, reptiles, insects, and equally great numbers of microscopic forms The trees, which man usually considers as forming the forest, and which he prizes for their utility and beauty, are merely one element in this complex association. Each tree species and each individual lives, grows, reproduces itself, and dies only in relation to its environment, composed of these numerous other forms of life and the soil and climatic conditions about it.

Each form of life and each individual organism within the forest possesses certain inherent characteristics which enable it to persist, grow, and reproduce itself To do these things it must secure certain life necessities—for a tree the requisite amount of sunlight, soil moisture, plant foods dissolved in the soil moisture, and sufficient room in the soil to establish a root system which will gather the food and moisture and anchor it firmly in place It must escape by good fortune or defend itself by protective devices from attacks of many insect and fungous parasites. In this life struggle it exerts forces which react upon its competing neighbors. The struggle between individuals is keen, and quarter is neither asked nor given. The forces exerted by each individual tree in the forest in its efforts to secure its necessities react upon every other near-by individual, and each of them is subjected to the

forces exerted by all other organisms. The total of the inherent life forces of all surrounding organisms constitutes an important part of the environment within which each individual tree struggles for existence. The result is an extremely complex focus of biotic forces reacting upon the individual tree. These biotic forces plus soil and climate constitute the whole forest environment within which the tree must succeed or fail, live or die. Soil and climatic factors of environment are more stable than the biotic factors, but fluctuations in precipitation and temperature, particularly when extended through time, may profoundly affect the entire biotic complex, and thus the forest as a whole as well as each individual tree Also, the nature of the forest soil may be affected for a considerable period by severe forest fires.

The ecological effects of these numerous environmental forces upon the forest as a whole and upon the tree in the forest are in many cases far from obvious, extremely subtle, but profound Because of them the forest is maintained seemingly in a condition of static balance but in reality in a state of dynamic progress, moving toward but seldom attaining a climax or nearly static condition Their effect upon a forest growing under natural conditions is fairly certain and generally predictable But because of their complexity and their delicately balanced interrelationships they are particularly susceptible to disturbance by artificial influences. Man's activities in his harvesting of the trees, the fires which too frequently accompany his presence, his use of the undergrowth or meadow for pasturing domestic livestock, his very presence in great numbers, have a powerful effect upon the environmental forces within the forest and thus upon the forest itself In fact, man and his activities become one of this series of environmental forces. Forests being used by man for any purpose must continue to exist in an environment of which man is a part Realization of his effect upon the forest, his power to preserve or to destroy it, will determine his success or failure in maintaining forests to be used both as a source of raw materials and for the indirect values which he prizes so highly.

Wise management of a forest involves using these natural forces rather than replacing them with artificial conditions Generally speaking, the most productive forest will be that in which the natural forces of growth are permitted to carry on their optimum work unhampered The system of management which protects the forest from its enemies, subjects it to the minimum of disturbance, and favors by whatever means possible the tree species most valuable to man, growing in the most usable form, will be most successful

Effect of Growing Conditions on Forests

The extent of the Pacific Northwest, from the Pacific Ocean to the Continental Divide in Montana, and from the Canadian boundary to the southern edge of Idaho, gives rise to a great variety of growing conditions. The annual precipitation on the western, ocean-facing slopes of the Olympic Mountains and the Coast Range is the heaviest in the United States, in some localities averaging 120 inches. This precipitation is materially less in the trough between the Olympic Mountain-Coast Range system and the Cascade Range. Again this precipitation is sharply decreased east of the Cascade Range until, in the Intermountain Region, semiarid conditions prevail, with annual precipitations decreasing in many parts to 10 inches or less Farther to the east the Selkirk, Bitterroot, and Rocky Mountains interpose their barriers to the west winds from the ocean and thus secure from those air currents most of the moisture not lost in their passage over the mountains to the west Thus, the northern Rocky Mountain Region with averages of 15 to 40 inches has a greater annual precipitation than the Intermountain Region. Similarly, as distance from the Pacific Ocean increases, seasonal variations in temperature increase On the west slopes of the Olympic Mountain-Coast Range systems, monthly mean temperatures through the year vary between 60° and 30°. In contrast, those in the Intermountain and Northern Rocky Mountain areas are 60° and 20°.

There are other factors, often more local in nature, which affect growing conditions profoundly, and thereby affect the character and rate of growth of a forest Daily, seasonal, and yearly ranges of temperature generally increase with altitude. Throughout the world the western sides of hills, mountains, and mountain ranges derive greater amounts of heat from the sun's rays than the eastern sides, and are therefore warmer and as a general rule drier In the northern hemisphere, the southern sides of mountains receive more solar heat than the northern sides and are thus similarly warmer and drier. The effect of these differences in the amount of solar heat received on different slopes is powerful The differences affect plant growth profoundly except where other factors, such as proximity to cool, moisture-laden winds from the ocean, may outweigh them This occurs in the West Coast Subregion where the west slopes receive greater precipitation from the ocean winds than the east slopes. Various types of soil may differ to a marked degree in depth, ability to retain moisture, and amounts of available plant food. By such means they affect the forests which grow upon them.

The effect of these factors of environment is to cause great bands or zones of vegetation within the Pacific Northwest And because their effect is greater in an east and west direction than north to south, major variations from east to west are more pronounced than from north to south Although growth conditions west of the Cascade Range vary considerably from the Canadian boundary to the southern border of Oregon, these differences are much less striking and important than those between the west slopes of the Cascade Range and the east slopes of that range. Similarly, there is less contrast between the vegetation of the Blue Mountains of Oregon and the Colville Mountains of northern Washington than between either of them and points of equal latitude west of the Cascade Range.

Forest Types

The forests of the Pacific Northwest are greatly affected by these major environmental factors Their result is most apparent in the general character, composition by species, and rate of growth of forests in different parts of the region. These differences are recognized both for purposes of management and classification as forest type A forest type is a forest broadly uniform in character and composition.

The term "forest type," as commonly used, contains within its meaning several diverse elements which detract from its simplicity The two principal elements are most easily described as the concepts of vegetative type and of economic type If a forest type were considered solely as a vegetative type its recognition would be based only upon the tree species of which it was comprised, and it would probably be named for the most numerous one or two species. Such a type designation would be primarily descriptive of what the type contained However, since mankind values certain tree species more highly than others, and since the most valuable species within a certain type may not be the most numerous, the economic element frequently enters into forest type definition and designation. An excellent example of this use of economic value in forest type designation is the western white pine type in northeastern Washington, northern Idaho, and northwestern Montana In parts of this type, western white pine may predominate; in other places it may constitute a relatively small percentage of the stand, either by number of trees or timber volume The value of this species is, however, far greater than that of any other species associated with it Considered as a vegetative type, the western white pine type would probably be named hemlock type in part and white fir type in parts of its range as in various places each of these species predominates

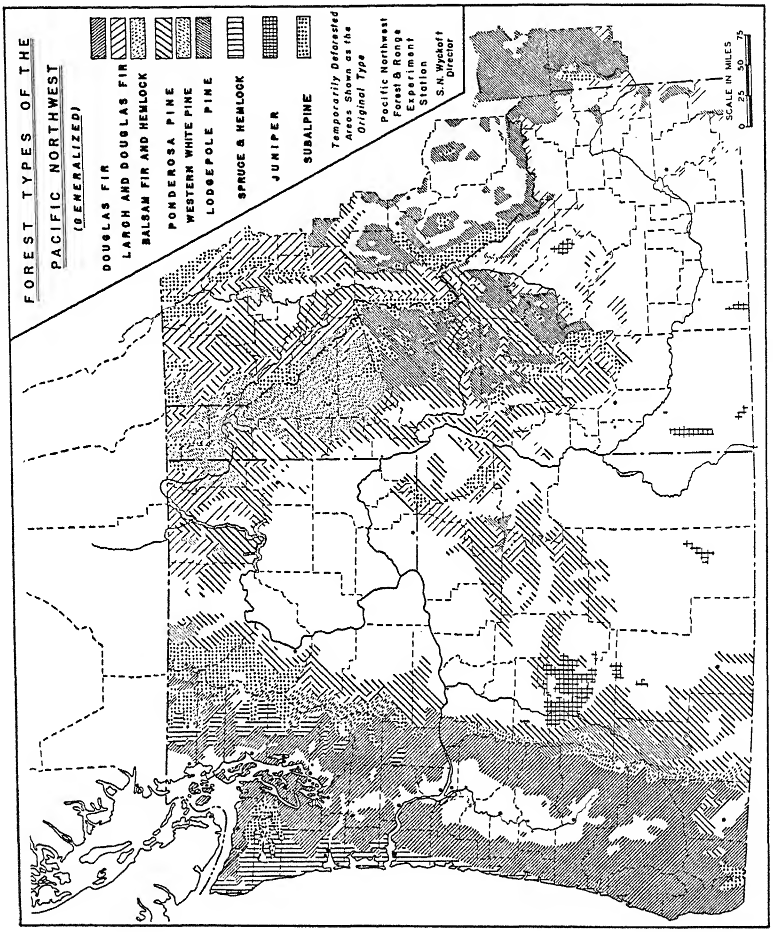

FIG. 83. Forest types of Pacific Northwest.

in number. But because of the pre-eminent value of the western white pine, the type as a whole is given this name. The effect of this economic consideration is greater than merely that of name The aim of forest management by professional foresters and landowners is to increase the amount of western white pine within this type at the expense of the less valuable hemlock and white fir.

For purposes of this discussion the forests of the Pacific Northwest have been divided into nine forest types The location of these is shown on the forest type map, Fig 83.

1. Spruce-Hemlock Type. The spruce-hemlock type comprises those forests within the West Coast Subregion, of which western hemlock (*Tsuga heterophylla* [Raf] Sargent) and Sitka spruce (*Picea sitchensis* [Bongard] Carriere) are the most numerous and most valuable elements It occurs in a narrow belt along the Pacific Ocean, west of the Coast Range and Olympic Mountains, extending southward to a point about halfway down the Oregon coast It is also found to a lesser extent at altitudes of 2,500 to 4,000 on the west slope of the Cascade Range of Washington, although spruce is frequently absent here The species within this type are moisture loving and flourish under the conditions of heavy precipitation and moderate temperatures which occur in the range of the type

The principal elements of the spruce-hemlock type are western hemlock, averaging about 60 per cent, Sitka spruce, about 11 per cent, and western red cedar (*Thuja plicata* D Don), about 16 per cent. The remaining 13 per cent consists of Pacific silver fir (*Abies amabilis* [Douglas] Forbes), grand fir (*Abies grandis* [Lindley]), Douglas fir (*Pseudotsuga taxifolia* [Lambert] Britton), and small amounts of red alder (*Alnus rubra* [Bongard]) and bigleaf maple (*Acer macrophyllum* Pursh) As in some other forest types, the species named first in the type designation is not the most numerous, but is recognized in the name because of its relatively high economic value

2. Douglas Fir Type The Douglas fir type is that forest within the West Coast Subregion in which Douglas fir predominates Over much of its extent, Douglas fir constitutes 90 per cent of the timber volume Its principal associates are western hemlock, western red cedar, and grand fir, with Pacific silver fir at higher elevations In smaller amounts it also contains Sitka spruce, noble fir (*Abies nobilis* Lindley), western white pine (*Pinus monticola* Douglas), red alder, and bigleaf maple. In southwestern Oregon, near the southern limit of the type, it also contains some ponderosa pine (*Pinus ponderosa* Douglas), sugar pine (*Pinus lambertiana* Douglas), California incense cedar (*Libocedrus*

decurrens Torrey), and Port Orford white cedar (*Chamaecyparis lawsoniana* [A. Murray] Parlatore), a species of very limited distribution but of particularly high value.

The Douglas fir type covers the great sweep of area throughout the north and south length of the West Coast Subregion, from the margin of the coastal strip of spruce-hemlock type, across the Coast Range, Puget Trough, Willamette Valley, and Rogue River Valley, and into the Cascade Range, extending up their western slopes until changes in growing conditions give rise to other types. It occurs in areas where precipitation is ample for luxuriant tree growth but less in amount than where the spruce-hemlock type thrives, and where temperatures are moderate. In extent it far exceeds any other forest type in the West Coast Subregion, and in commercial value any other type in the entire Pacific Northwest.

3. Balsam Fir-Hemlock Type. The lower slopes of the western face of the Cascade Range, favored by conditions of precipitation and temperature for tree growth, bear forests of the Douglas fir and spruce-hemlock types. As elevations increase, conditions are found which are less favorable to the principal species of these two types. As a result, other species appear, and, although the species of the lower types still persist, they generally occur as a smaller proportion of the forest stand. The resulting forest is thus altered in character, to the extent that a different forest type, known as the balsam fir-hemlock type, is formed. It is characterized by a predominance of the balsam firs (the true firs in distinction to Douglas fir) and the hemlocks. The balsam firs—Pacific silver fir, noble fir, and alpine fir (*Abies lasiocarpa* [Hooker] Nuttall)—generally constitute about 45 per cent on the average of the forest volume, and the hemlocks—western hemlock and mountain hemlock (*Tsuga mertensiana* [Bongard] Sargent)—an equal part. In the southern part of the type, Shasta red fir (*Abies magnifica shastensis* Lemmon) is quite frequent. The remaining 10 per cent consists of Douglas fir, western red cedar, Engelmann spruce (*Picea engelmanni* [Parry] Engelmann) and Alaska yellow cedar (*Chamaecyparis nootkatensis* [Lambert] Spach).

The balsam fir-hemlock type occurs in a belt, generally narrow but irregular in width, on the upper slopes of the Cascade Range. It generally lies between altitudinal limits of 3,500 feet to 5,500 feet of elevation. Precipitation is generally ample for other types, but more severe temperatures favor the more hardy tree species appearing in this type.

4. Subalpine Type. Altitudinally above the balsam fir-hemlock type and extending to timber line, the subalpine forest type occurs. An area

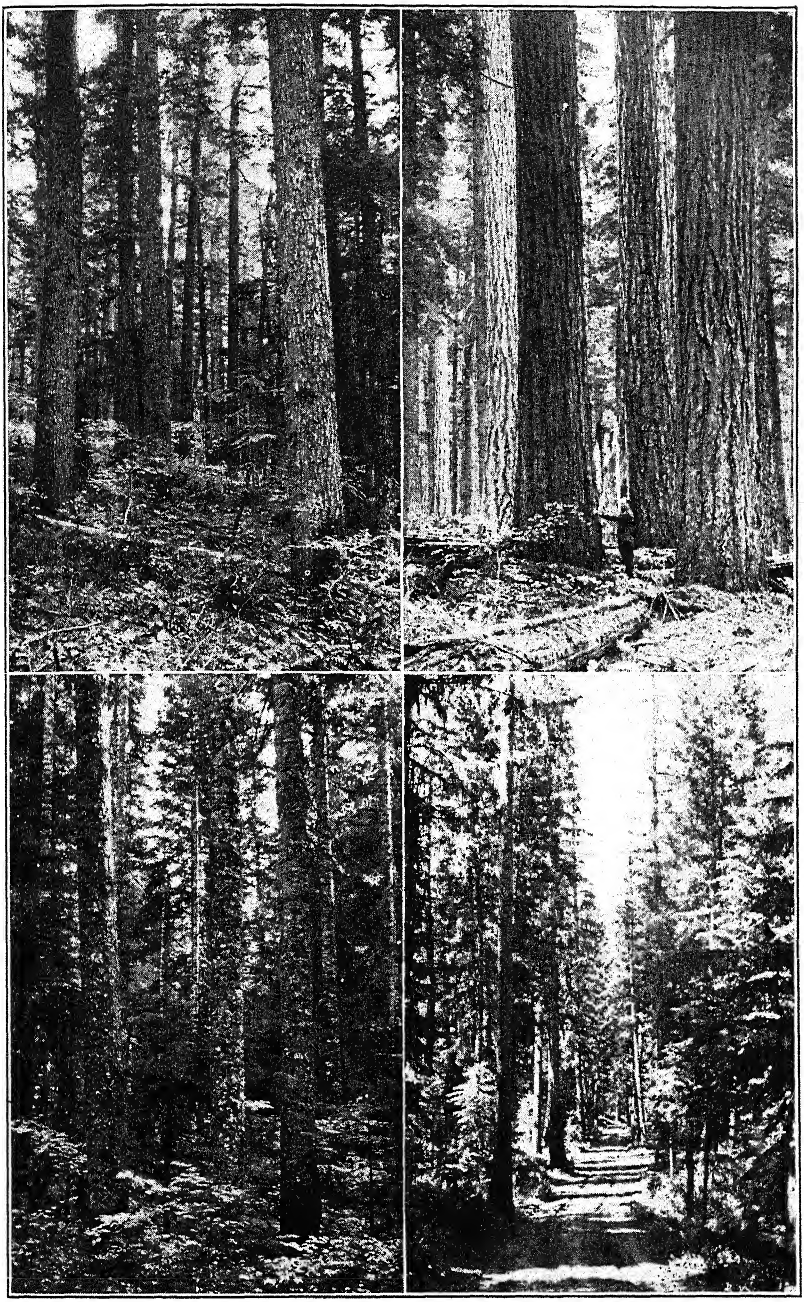

FIG. 84. *Upper left:* mature western hemlock. *Upper right:* mature Douglas fir. *Lower left:* silver fir. *Lower right:* larch-Douglas fir forest in Montana.

of ample precipitation but with heavy snows and severe temperatures in winter and thin soils, it is less favorable to tree growth than the lower elevations. Trees are uniformly smaller in size, poorly formed, and generally unmerchantable At this altitude and under these conditions only the hardier species persist These subalpine forests consist of alpine fir, noble fir, Pacific silver fir, Shasta red fir, mountain hemlock, Engelmann spruce, Alaska yellow cedar, western white pine, whitebark pine (*Pinus albicaulis* Engelmann), lodgepole pine (*Pinus contorta latifolia* Engelm), and alpine larch (*Larix lyallii* Parlatore).

The subalpine type extends as an irregular belt on the upper slopes, both east and west, of the Cascade Range, in the Olympic, Selkirk, Bitterroot, and Rocky Mountains, and to a limited extent in the Blue Mountains. Unsuited to the growth of commercial forests, its importance lies in its scenic beauty and consequent use for forest recreation, its value for summer grazing, and its function as a storehouse of winter snows, later to melt and feed the streams used by man at lower altitudes.

5. Ponderosa Pine Type. East of the high elevations of the Cascade Range, where protection from the more even-temperatured and moisture-laden winds of the Pacific Ocean gives rise to more severe conditions, the ponderosa pine forest type occurs. Extending from the Black Hills of South Dakota to the Cascade Range and the Sierra Nevada, and from eastern British Columbia to New Mexico and Arizona, it is widely distributed over the mountainous portions of the Pacific Northwest Incapable of attaining the tree size or growth rate of the forest types of the West Coast Subregion, it is, nevertheless, because of its extent and the value of ponderosa pine, economically one of the most important forest types of the region

The key species in this type is ponderosa pine, its most common associates are grand fir, western larch (*Larix occidentalis* Nuttall), Douglas fir, and lodgepole pine, with California incense cedar and sugar pine in southern Oregon Ponderosa pine frequently comprises 85 per cent of the total forest volume within the type.

In contrast to the heavy stands and dense, luxuriant undergrowth so frequently encountered in the forest types of the West Coast Subregion, the ponderosa pine type is open, the trees are more widely spaced, and shrubby undergrowth is sparse or sometimes absent This condition gives rise to a parklike forest, relatively easy to traverse. The ground is often covered with grasses, annual plants, and shrubs valuable for forage. As a result, large areas of the ponderosa pine type are utilized for grazing, as well as for timber production.

6. *Western White Pine Type.* The western white pine type occurs only in the Northern Rocky Mountain Subregion, except for very limited areas in the southwestern part of Oregon. Clothing the middle to lower slopes of the Rocky, Bitterroot, and Selkirk mountains, but generally occurring at slightly higher altitudes than the ponderosa pine type, the western white pine type is a forest of dense growth of which western white pine is the most important species economically. Its most frequent associates are western hemlock, grand fir, western larch, western red cedar, and lodgepole pine. Rough terrain resulting in high logging costs, high costs of protection from fire, white pine blister rust and insects, and lack of cheap water transportation to the large eastern markets combine to set up conditions under which the only species within the type that can usually be logged at a profit are western white pine and western red celar. For this reason the designation of large areas as western white pine type is based more upon economic than biotic considerations. In many cases, western white pine may constitute a relatively small part of the forest stand within the type, either in number of trees or volume of timber, but nevertheless may represent the principal financial value. The proportion of species may vary over wide limits in the type. In local areas western white pine may comprise 60 per cent to 80 per cent of the forest stand, in others it may be as low as 15 per cent to 20 per cent. The occurrence of the associated species will vary likewise.

7. *Larch-Douglas Fir Type.* The larch-Douglas fir forest type occurs in the Northern Rocky Mountain Subregion and in the Blue Mountains, Colville Mountains, and east slopes of the northern Cascade Range in the Intermountain Subregion. It is generally found at about the same altitude as the western white pine type. It is a type containing a number of species, varying in proportion in different localities. None of the principal species are outstanding in value in relation to the others. The principal components of the type are western larch, Douglas fir, grand fir, and lodgepole pine. Scattered throughout the type western red cedar is found, and in certain localities Engelmann spruce is numerous, these two species being the most valuable within the type.

8. *Lodgepole Pine Type.* At relatively high elevations in the Northern Rocky Mountain and Intermountain Subregions, and to a lesser extent in the West Coast Subregion, there occur extensive areas of lodgepole pine type. In some localities, particularly at lower elevations, the type is temporary in nature, owing to the fact that lodgepole pine may take possession of the ground after a forest fire, later to be replaced

by other species At higher altitudes, the type is more permanent in nature. It frequently forms dense, almost pure, stands of lodgepole pine, extending almost unbroken over large areas

9. Juniper Type. The juniper forest type occurs in the Intermountain Subregion, and to a limited extent in the Northern Rocky Mountain Subregion. Lying altitudinally below the other types of these subregions, it is the last outpost of forest growth as forest and semidesert meet. The type usually consists of very open stands of Sierra juniper (*Juniperus occidentalis* Hooker), the trees interspersed with mountain mahogany (*Cercocarpus* spp.), and the shrubby flora of the open semidesert

THE FOREST AS AN ECONOMIC ASSET

Volume and Kinds of Timber

At the present time the commercial forest lands of the Pacific Northwest bear 893.7 billion board feet, lumber tally,[2] of merchantable timber (Table 14). This constitutes about half of the nation's remaining timber supply. Because of the great differences in growing conditions within the Region, several different species of forest trees are represented in this total. Douglas fir is most important from the standpoint of volume, with ponderosa pine second, and hemlock third Several other species, such as cedar, spruce, and western white pine, have high value because of their special uses, but are relatively small in total volume. In considering volumes of timber by species, special significance should be given to hemlock and the balsam firs, especially white fir, grand fir, Pacific silver fir, and noble fir These constitute the source of material from which wood pulp is manufactured They are generally termed "pulpwood species" and are the basis of a large pulping industry, particularly in the West Coast Subregion.

Development of Forest Land Ownership

The rapid-moving history of the settlement of the Pacific Northwest reveals the causes of the present complex and chaotic pattern of forest land ownership existing within the region Early Spanish and English explorers reached southern Oregon waters the middle of the sixteenth century, but not until the end of the eighteenth century were landings made and the Columbia River ascended. A few years later, Lewis and Clark came overland, reaching the Pacific in 1805. Trappers and fur traders arrived virtually on the heels of Lewis and Clark. In 1811 John

[2] Lumber tally is the system of measurement which reckons the contents of standing timber in terms of the volume of lumber which can be produced from it

Jacob Astor's company founded Astoria, to be succeeded within two years by the North West Company, which in turn was succeeded in 1821 by Hudson's Bay Company. American missionaries followed the trappers, arriving from 1834 on Settlers came in increasing numbers, and in 1843 the first organized government was formed by United States citizens at Champoeg, Oregon. In 1846 the boundary dispute between Great Britain and the United States over the Oregon Territory

TABLE 14

STAND OF SAW TIMBER ON COMMERCIAL FOREST LAND IN THE PACIFIC NORTHWEST, BY SPECIES AND SUBREGION

(Million feet, B M , lumber tally—i e , 000,000 omitted)

Kind of Wood (species)	Total	West Coast Subregion	Northern Rocky Mountain Subregion	Inter-mountain Subregion
Conifers				
Douglas fir	431,462	371,771	20,211	39,480
Ponderosa pine	131,624	5,682	17,376	108,566
Balsam fir	75,797	49,343	7,606	18,848
Western hemlock	115,551	112,849	1,418	1,284
Spruce	26,664	12,820	8,369	5,475
Cedar	37,208	32,102	4,558	548
Lodgepole pine	12,430		7,541	4,889
Sugar pine	4,895	4,086		809
Western white pine	18,333	2,951	14,620	762
Western larch	25,860	126	16,662	9,072
Other conifers	8,934	5,864	370	2,700
Total conifers	888,758	597,594	98,731	192,433
Hardwoods	4,956	4,655	200	101
Grand total	893,714	602,249	98,931	192,534

was settled by treaty, and all lands south of the forty-ninth parallel of latitude, except Vancouver Island, were recognized as belonging to the United States. In 1848 Oregon became a territory, comprising a large part of what is now the Pacific Northwest Thus in less than half a century the period of exploration, settlement, and local government organization was passed.

The early settlers were primarily interested in agriculture, and their selection of land claims was made with that in mind, but there was little open country and many of the old claims were wooded Sawmills were established to furnish local building materials, and it soon be-

came apparent that one of the chief products of this new territory was to be lumber. The development of trans-Pacific commerce opened an Asiatic market eager for the lumber which the region could supply. The completion of the first transcontinental railroad via the Columbia River in 1883 and the linking of Oregon and California by rail in 1887 gave impetus to the infant lumber industry and new markets were opened. Acquisition of lands for their forest wealth which had begun slowly with the tide of western settlement after the Civil War increased rapidly.

The settlement of the boundary dispute in 1846 placed in the hands of the federal government a vast public domain. It was the policy of the government, at that time, to transfer the public domain to other ownerships as rapidly as possible, and several important enactments of the Congress contributed to this end. Settlers' titles in the Oregon Territory were recognized upon evidence of occupancy and development of the land prior to the 1846 treaty by the passing in 1850 of the Oregon Donation Land Act by Congress The Pre-emption Act of 1841 and later the several homestead acts, the first of which became law in 1862, and the Timber and Stone Act of 1878 contributed materially to the process of converting the public domain into private ownership. These laws differed in important details, but they all contained the basic provision that the individual could secure specified acreages of public domain land by purchase at a uniform and low price or by living upon the land and improving it.

The early development of transcontinental and western coastwise railroads was accompanied by the transportation grants. To aid in these developments, the federal government deeded to the railroad companies the alternate sections of public domain land on a strip 10 to 40 miles wide on each side of the right-of-way. There were also provisions for the deeding of lands to the railroads within an additional area, if the alternate sections within the designated strip were already in private ownership. A number of land grants were also made for the construction of wagon roads.

As the several states of the Pacific Northwest were formed within the Oregon Territory, commencing in 1859 with Oregon, specific grants of public domain lands were made to them to support certain state institutions, chiefly schools. By this means, sections 16 and 36 of each township, or 1,280 acres out of every 23,040 acres, were given to the states. Other state grants for educational and development purposes were also made.

The operation of these policies and legal enactments resulted in the

rapid transfer of much of the public domain from federal to other ownerships. The forest lands of the Pacific Northwest were involved in this transfer. Later as the rapid rate of depletion of the forest resource became apparent and corporations and individuals through abuse of the Timber and Stone Act and other subterfuges began to corner huge holdings of timberland, national apprehension was manifested, and resulted in the formation in 1891 of forest reserves, later established under jurisdiction of the secretary of agriculture as the national forests To preserve special scenic and recreation values, the national parks and national monuments were also established, and are maintained in federal ownership under the jurisdiction of the secretary of interior.

A further category of land ownership was established by the treaties executed between the federal government and the several Indian tribes. Certain lands, mostly but not all within reservations, and some of which bore valuable timber, were recognized as in Indian ownership, either individual or tribal.

In recent years, an increasing amount of forest land has reverted to county ownership by foreclosure for delinquent taxes Much but not all of this land is deforested. The tendency of the county governments has been to endeavor to return such lands to private ownership by sale, frequently at low prices. This policy has not been generally successful, and many of these land parcels have reverted to county ownership a second time The result has been an unstable condition of land ownership, such land often being referred to as "no man's land" Much of it has been inadequately protected from fire, with the result that its forest productivity is materially decreased

The effect of these policies and laws has been to set up an extremely complex pattern of ownership of forest land (Tables 15 and 16) Small parcels of land owned by individuals, the holdings of large lumber companies, or holding companies, tax-delinquent lands owned by the counties, state-owned lands and national forest lands or other forms of federal ownership are frequently intermingled in an intricate pattern within a single forest area which quite obviously demands unified management. This condition of mixed ownership, with the attendant impossibility of effective management and protection, constitutes one of the serious impediments to the orderly use of forest lands of the Pacific Northwest for continued production of forest products. One of the most difficult problems now faced is to establish a logical, orderly ownership pattern of forest lands in the hands of responsible public and private agencies. The operating policies of such agencies can differ to a considerable degree within the field of sound management. But no

policy can be effective under ownership conditions which make the unified management of single areas impossible

Productive Condition of Forest Lands

The commercial forest lands of the Region are in varying conditions of productivity Large areas have been cut over On others, the original

TABLE 15

OWNERSHIP OF COMMERCIAL FOREST LAND IN PACIFIC NORTHWEST, BY SUBREGION, AS OF JULY 1, 1938

(Thousands of acres)

Subregion	Total	Federally Owned and Managed				State, County, and Municipal	Private
		Total	National Forest	Indian Reservation	Other		
West Coast*	25,790	9,888	7,329	220	2,339	1,653	14,249
Northern Rocky Mts †	21,235	12,879	11,849	331	699	1,562	6,794
Intermountain ‡	28,176	20,754	15,663	2,286	2,805	811	6,611
Total	75,201	43,521	34,841	2,837	5,843	4,026	27,654

* Oregon and Washington west of the Cascade summit.
† North Idaho, northeastern Washington, and western Montana.
‡ Remainder of Oregon and Washington, south Idaho, and northwest Wyoming

TABLE 16

OWNERSHIP OF SAW-TIMBER STAND IN PACIFIC NORTHWEST, BY SUBREGION, AS OF JULY 1, 1938

(Million feet, board measure, lumber tally)

Subregion	Total	Federally Owned and Managed				State, County, and Municipal	Private
		Total	National Forest	Indian Reservation	Other		
West Coast	602,249	269,059	208,035	5,052	55,972	33,180	300,010
Northern Rocky Mts	98,931	51,575	47,889	1,703	1,983	10,437	36,919
Intermountain	192,534	141,089	115,266	21,378	4,445	5,664	45,781
Total	893,714	461,723	371,190	28,133	62,400	49,281	382,710

forest growth has been burned Such areas vary greatly in their present condition In general these lands can be classified into five groups, generally indicative of their condition of forest growth and the nature of that growth Table 12 shows this grouping by subregions

Forest Growth and Depletion

An understanding of the dynamic nature of a forest, its quality of constant change, makes it apparent that two opposing forces are constantly at work within it—growth and depletion Growth is always taking place within the living forest, although its rate varies greatly with the age of the forest, its density, the species of trees, and the site quality, or productive capacity of the soil and climate Also, depletion, or loss, is constantly occurring The forces of depletion are of two types. One consists of normal, reasonably uniform losses due to decay, death of old trees, incidental insect killing, and occasional wind throw The second type is more serious, comprising losses due to large, catastrophic fires, epidemics of fungous diseases or insect infestations, and cutting depletion

In a mature forest growing under natural conditions the forces of growth and normal depletion will, over large areas, neutralize each other. Within such a forest there occurs a reasonably uniform volume of wood material, this uniformity being maintained by the steady replacement through growth of the volume lost by normal depletion Occasional catastrophic fires and epidemics undoubtedly occurred under natural conditions, and they doubtless disturbed temporarily the relation between growth and depletion in the localities concerned But they were soon followed by the appearance of young forests which, by the vigor of their growth, re-established the normal balance

The advance of settlement by the white man soon resulted in a disturbance of this balance between growth and depletion Cutting of the forest for industrial use, land clearing, and a marked increase in the number of forest fires greatly augmented the rate of depletion without any corresponding increase in growth As a result, the forests of the Pacific Northwest are now being depleted much more rapidly than they are growing. The current rate of depletion from all causes is estimated to be about 15 billion board feet annually

The recognition of four gradations of forest development will simplify an understanding of the expression of forest growth These are

1 The newly deforested area Land from which the forest has been removed by logging or fire, and upon which forest tree seedlings may just be appearing From the standpoint of forest production and growth the future

of such an area is entirely problematical In any event it contains no volume of forest growth measurable in terms of usable products

2. The established but very young forest Such an area may bear young trees in sufficient number to form a valuable forest In actual fact it is probably growing at a rapid rate, but the trees are still too small to be measured in terms of usable lumber or pulpwood

3 The older or advanced second-growth forest In this case the trees have attained sufficient size to contain measurable amounts of usable material, and the rate of increase, through growth, of that usable material can be measured

4 The old-growth, mature forest Here the rate of growth has slackened, through maturity, until it is no greater than the rate of depletion The forest has reached a static condition, so far as net growth (growth minus depletion) is concerned.

Figures on the amount of current forest growth in any region or locality are based upon the third of these classifications, the advanced second-growth forest. The first two are making no growth measurable as a usable product and the last is static as to net growth. Therefore, the *amount* of growth for the region as a whole will be determined by the *rate* of growth in the older second-growth forests, and by the *extent* of these second-growth forests in the region

A large area of old-growth virgin forest is, because of its static condition, making no net growth As cutting occurs, however, and if proper precautions are taken to insure reproduction, this condition is changed A new forest appears and grows. As it advances in age it reaches the stage of measurable advanced second growth. If allowed to develop undamaged it will finally reach again the static condition which existed prior to cutting. But until such time as the growth is so slackened that it only equals depletion, the forest capital is paying interest in the form of growth. Unless other factors of a financial nature intervene, the most profitable time at which to harvest such a forest will be shortly before the static condition is reached when average growth rates are at their apex.

This discussion has concerned itself only with volume growth. Quality growth must also be considered. The highest-quality lumber, and therefore the most valuable, is derived from the older trees, those which long ago lost their lower limbs and have grown "clear" lumber, free from knots Hence it may be financially desirable to postpone cutting past the period of rapid growth, the relative slowness of later growth being compensated by its added value. Despite the fact that they are now making practically no net growth, the old-growth, virgin forests of the Pacific Northwest contain a high quality of lumber which

will probably never be obtainable in the forests of the future, because the future forests will never attain the same age The rapid cutting of the present old-growth forests will therefore remove a type of resource which will not be available again

Table 12 shows the condition of the principal commercial forest types of the Pacific Northwest in relation to their condition of growth. In this tabulation, class 3, merchantable softwood second growth, contains those areas upon which occur stands of trees large enough to be measured in board-foot volume. This method of measurement is used because the principal species in most of the types are used for lumber rather than for pulp Had the acreage for class 3 been based upon trees large enough for pulp use, areas bearing smaller trees would have been included, the figures in class 3 would have been larger and those in class 2, young softwood second growth, correspondingly smaller.

Current Growth and Potential Growth

The preceding discussion of growth is limited to that termed by foresters as current growth It is generally expressed as current annual growth—the volume of growth actually occurring within a forest area in the current year on trees of merchantable size It is limited to the growth within the area designated in Table 12 as class 3 and amounts to —5 2 billion board feet in this region. Another basis for growth calculation is frequently used to express more completely the potential power of a forest region to grow lumber or other usable products. This is known as potential annual growth It is the calculated expression of the ability of the area as a whole to produce timber were it all placed under reasonably intensive forest management.

In this region, potential annual growth amounts to about three times the current growth. The establishment of such management over a large forest area would profoundly affect the proportion of the area to be found in each of the four classes shown in Table 12. Class 4, old growth, would practically disappear Under forest management all mature commercial forests would be cut at or before the point of equal growth and depletion Class 1, little or no reproduction, would be limited to lands so recently logged that new forest growth had had no opportunity to appear With adequate protection from fire and provisions for reseeding, it would no longer contain areas removed from forest production for long and indefinite periods. Except for the newly logged areas in class 1, the forest area, with certain fluctuations due to relatively short-time variations in economic conditions, would consist of approximately equal areas of classes 2 and 3 All these classes

of conditions of forest land are found in the Pacific Northwest In fact, class 4 exists here to a greater extent than in any other part of the United States. Theoretical considerations might dictate the removal of these static, old-growth forests as rapidly as possible, in order to put all our forests into a growing condition But two economic considerations are of greater weight. First, the rapid liquidation of these old-growth forests would be followed by a serious diminution in the lumber industry because of the relative scarcity of the older ages of class 3, now ready to cut Second, the old-growth forests contain high-valued lumber which will not exist in the younger forests of the future It would be the part of economic wisdom to spread the use of this high-grade material over a long rather than a short time.

LOGGING AND MANUFACTURE OF FOREST PRODUCTS

The Region As a Whole

The forest, composed of growing, mature, and decadent trees, presupposes use if man is to obtain the wealth produced by nature Man can aid natural processes through removal of mature and overmature trees which no longer produce wood fiber at the maximum rate, releasing the soil and space occupied by nonproducing trees to young vigorous ones which are producing at a high rate Thus through wise use of forest products man not only perpetuates but also enhances his natural heritage.

One of the first manufactured products of the Pacific Northwest was lumber, produced in a sawmill established at Fort Vancouver, in 1827, by Dr. John McLoughlin, factor of the Hudson's Bay Company. This mill, capable of producing 3,000 board feet a day and manned by Hawaiians, was the forerunner of the modern, massive mills, some of which produce over a million feet of lumber a day (Table 17). Man continues to use the forests as a source of wealth, sometimes wisely, sometimes unwisely, but with a growing consciousness that wise use pays dividends not only to himself but also to society in the form of human values, such as permanent employment, permanent revenues, and permanent communities.

The forests of the Pacific Northwest currently provide products valued at more than $500,000,000, direct employment for about 120,000 people, and indirect employment through service industries which is impossible to estimate Many communities owe their continued existence to the extraction and manufacture of forest products, and would virtually cease to exist if the forest industries stopped operations.

TABLE 17

NUMBER AND AGGREGATE INSTALLED CAPACITY PER 8-HOUR SHIFT OF ACTIVE AND IDLE SAWMILLS IN THE PACIFIC NORTHWEST, BY SIZE CLASS, DURING 1937

Capacity Class per 8-Hour Shift	Number			Aggregate Capacity		
	Idle	Active	Total	Idle	Active	Total
1 000 bd ft				*1,000 bd ft*	*1,000 bd ft*	*1,000 bd ft*
1– 20	153	1,056	1,209	1,033	8,117	9,150
21– 50	15	238	253	510	7,856	8,366
51–100	6	83	89	465	6,688	7,153
101–200	1	83	84	200	12,970	13,170
201–500		47	47		13,919	13,919
Total	175	1,507	1,682	2,208	49,550	51,758

West Coast Forests

The West Coast Subregion, highly accessible to tidewater, was the first to be exploited The massive trees challenged the equipment then available, but new types of equipment and of logging and manufacturing practices were developed to meet this challenge Early logging was confined to the vicinity of streams or tidewater, where trees could be felled directly into the water or could be rolled and manhandled into the water with primitive equipment Then ox teams were introduced to haul logs along improvised roads, thus extending the sphere of operations. Naturally, the logger of those days cut the forest selectively He could not afford to take trees inferior because of size or quality, he chose only the best. Eventually the logger harnessed steam through the machine known as the "donkey," a combination of power-operated drums and cables, which in its highest development could bring in logs of any size for long distances regardless of rough terrain The introduction of power in the woods and rail transportation to the mill coincided with the development of high-speed sawmill machinery and opened the way for mass production But these developments took a heavy toll of the forest. Small logs and small trees could not be economically handled wtih such equipment, the press of production would not permit saving them; the enormous areas logged in a season and the debris left on the ground constituted such a fire hazard that public opinion decreed that such areas must be burned under control at the end of the season to reduce the hazard. Few, if any, standing

trees survived this treatment to reseed the area, but through seed blown in from adjacent uncut forests (if not too far removed) in many cases a new forest could and did start—often to be destroyed by recurrent fires. The futility of this was apparent to all, but little or nothing was done until lighter and more mobile equipment in the form of caterpillar tractors and motor trucks was introduced in recent years This equipment again permits selection of the desired trees without destruction of those left, thus completing a cycle from selection through clear cutting to selection. Clear cutting will probably always be necessary in stands of certain composition Selective logging is not adapted to all types of forest and still presents operating problems in places to which it is adapted.

With the opening of the forest area by roads and railroads the colorful logging camp of song and story became a thing of the past. The large camps tend to be more permanent, the loggers live there with their families and ride to work either on the logging trains or in their own automobiles. Fewer of the large camps now exist, there being a tendency, especially since the advent of recent social legislation, for timber owners to contract the logging and for the contractor to subcontract different steps in the logging process. The smaller logging companies usually employ local labor, or the laborers and their families follow the progress of timber cutting and establish new homes within commuting distance. In other words, the beginnings of a stabilized labor supply, dependent partially upon woods operations and partially upon what can be grown on a small homestead, are evident—just the setup which should be one of the major benefits deriving from sustained yield management

The problems arising from the size and volume of timber to be handled and abetted by an abundance of waterways facilitating storage and transportation created in the West Coast Subregion certain conditions peculiar to itself Among these are the independent logger and open log markets. The independent logger is one who has no interest in a sawmill; his only interest is getting the logs from the stump to the market He may own the land and stumpage, he may purchase stumpage only, or he may contract to log the stumpage owned by someone else. Under such a condition, the establishment of an open log market was inevitable. Such markets are found on Puget Sound, Willapa Harbor, Grays Harbor, and the Columbia River. To them the logger brings his logs, from them the mill operator purchases all or a part of his log requirements. Many sawmill operators, of course, own timberlands, many do their own logging, and some produce a sufficient

volume to meet their own requirements and a surplus to be sold on the market. Probably one-third of the log production of the West Coast Subregion is handled in the four markets combined.

Another peculiarity of the subregion is the volume exported as logs The bulk of the volume has been destined for the Orient, especially for Japan, but an appreciable volume of high-grade logs has gone to Europe. The trend became noticeable not more than 15 years ago and was given impetus during the depression years following 1931. Many of the Pacific countries, notably Japan, changed from the purchase of Jap squares, large timbers cut from the center of the logs, to the purchase of the entire log. This trend resulted from two factors—the desire to have a larger supply of clear lumber obtained from the outside of the log and the desire to utilize their own lower paid labor Prior to the outbreak of hostilities in China, Japan was buying logs, principally hemlock, Douglas fir, and Port Orford white cedar at the rate of 170 million feet annually. At the same time, prior to the present war, some 2 million feet were being shipped to European ports each year.

Importance of Douglas Fir. Douglas fir because of its properties has always been the species sought in the Douglas fir type, and it forms the major part of the lumber produced in the West Coast Subregion. The footage of this species increased from 1¾ billion board feet at the turn of the century to nearly 8½ billion board feet in 1926, in 1937 the production was 6¼ billion board feet. This lumber goes into every imaginable product and is shipped as clear-finished lumber, boards and timbers of all sizes for construction, large timbers for remanufacture. An appreciable part of the output is shipped by water. This has led to the shipment of much of the output green from the saw, because cargo shipment freight is paid upon the basis of stowage space rather than upon weight. There is a decided trend, however, in West Coast mills to season, usually artificially, an increasing proportion of their production, and some mills are now kiln-drying everything except the larger pieces, such as timbers. Recent experiments have indicated the feasibility of seasoning these items chemically—by the use of solutions of salt, urea, and other compounds There has also been progress along the line of better and more complete manufacture at the mill and in finishing and packaging as an aid in merchandising. This trend is evident in such advances as the plugging of knot holes with wood plastic, the selling of lumber, double-end trimmed to exact lengths, packed with a protective covering over the ends of high-grade lumber. The West Coast industry probably more than any other could profitably introduce a greater refinement in manufacture, thus providing

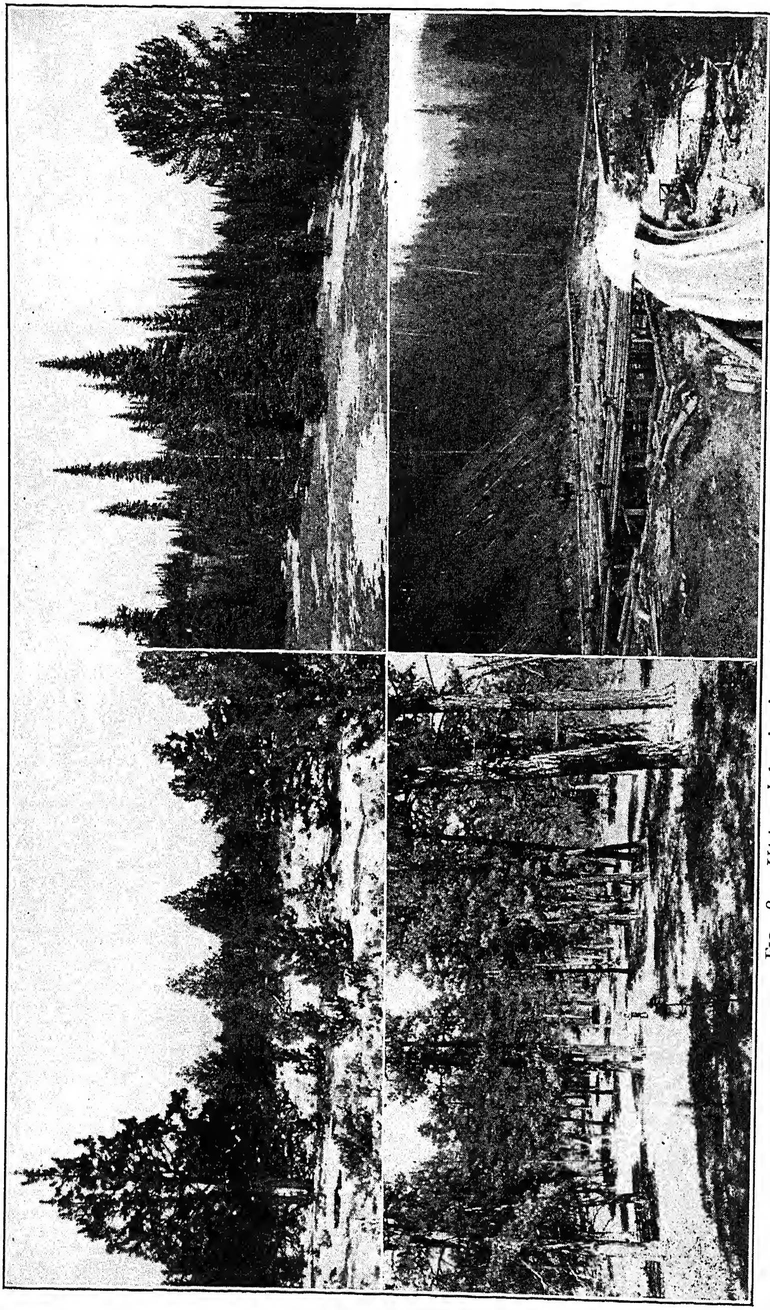

Fig. 85. *Upper left:* juniper. *Upper right:* subalpine type. *Lower left:* ponderosa pine. *Lower right:* logs being dumped into log flume.

more local labor and payrolls, and saving the consumer freight now paid on unusable material.

The economic utilization of waste in both woods and mill is still a big problem in all forest regions but especially so in the West Coast Subregion. Many trees and many rough logs do not yield a return commensurate with the cost of logging and milling and are now left in the woods Even now trees are cut and logs are brought in which are submarginal, i e , are handled only at a loss Low-grade lumber is a drug on a market so far removed from the largest consuming centers Unavoidable waste, developed during manufacture, is destroyed in open burners except within and in the vicinity of large communities Most of this waste is known to be convertible into usable products, but either the cost of accumulating and handling the raw material is excessive with present equipment or the products enter the market in competition with the better grades of lumber, thus depressing the price on them, or, in the case of chemical by-products, cannot enter the market in competition with materials from other sources of raw material For example, acetic acid and methyl alcohol derived from the distillation of hardwood waste cannot compete with the synthetic products; grain alcohol made from wood cannot compete with that made from molasses.

Not only is Douglas fir the primary species of the lumber industry (Table 18), it is also the backbone of the plywood industry which now has 29 mills employing 8,500 workers and producing products valued at $50,000,000 This industry, which peels logs into thin sheets and glues these together into panels of varying thickness and of greater strength than lumber of the same size, has until recently demanded the best quality of logs produced by the Douglas fir forests The supply of "peeler" logs has become scarcer, especially with the progress of logging to higher elevations where the timber is smaller As a consequence, the plywood industry has been forced to use logs of lower grade, resawing the clear veneer produced for panel faces, patching minor defects in face veneer, and using knotty veneer for cores or inner layers, when it does not show and where it does not affect the utility of the product. At the same time the industry has been seeking other sources of supply, especially in species such as sugar pine and ponderosa pine Investigations are now under way to determine the suitability of western hemlock and the balsam firs, and the economic factors to be taken under consideration if these species were to be used. The log supply for this industry is purchased on the open log market, none of the companies owning timberland except as they do so through their affiliation with a lumber company which does. Plywood competes with lumber to some

TABLE 18

PRODUCTION OF SAWLOGS AND OTHER FOREST PRODUCTS BY SPECIES, IN THOUSANDS OF BOARD FEET, LOG SCALE, IN THE PACIFIC NORTHWEST DURING 1937*

Species	Sawlogs Used for					Other Products									Grand Total
	Lumber	Pulp	Veneer	Shingles	Total	Posts	Poles and Piling	Fuel-wood	Ve-neer Blocks	Pulp Cord-wood	Mine Tim-bers	Hewed Ties	Shin-gle Bolts	Total	
Douglas fir	5,519,911	52,037	300,105		5,872,053	3,399	24,608	419,428	24,285		8,894	3,796		484,410	6,356,463
Western hem-lock	375,496	932,119	591		1,308,206			2,113		39,602	89			41,804	1,350,010
Sitka spruce	163,670	70,370	35,185		269,225		9		700	16,735	2			17,446	286,671
Western red cedar	109,697			437,176	546,873	15,209	48,062						10,000	73,271	620,144
Balsam firs	29,280	69,457	12		98,749			405		17,533				17,938	116,687
Ponderosa pine	2,005,676		1,354		2,007,030	1,018		80,609			973			82,600	2,089,630
Western white pine	515,262		212		515,474			50						50	515,524
Western larch	113,235				113,235	2,261		56,465			6,389	3,724		68,839	182,074
Port Orford white cedar	58,970		1,059		60,029		25							25	60,054
Other conifers	126,020			44	126,064	1,483	314	13,057			2,247	1,663		18,764	144,828
Hardwoods	44,104		5,368		49,472	350		42,967						43,317	92 789
Total	9,061,321	1,123,983	343,886	437,220	10,966,410	23,720	73,018	615,094	24,985	73,870	18,594	9,183	10,000	848,464	11,814,874

* Data on sawlogs are based on Bureau of Census information for 1937 Data on other products were estimated from data collected for the year 1930

extent, being suited to the same uses. But at the same time it widens the field of wood use by filling uses formerly monopolized by other materials.

Hemlock and Spruce. Western hemlock is the species of secondary importance in the Douglas fir type It is harvested with Douglas fir but is usually segregated on the log market. Prior to 1931 this species was increasing in importance in the lumber industry, largely because of an intensive campaign on the part of producers. But during the few succeeding years hemlock nearly disappeared from the market, and to date has not regained its competitive position During the interim the best of the material has been diverted to the pulp industry, which is now operating largely on this species. Approximately three-quarters of the wood used in this industry is western hemlock, Sitka spruce is one-tenth, Douglas fir one-tenth, and other species make up the remainder. Wood in log form makes up 70 per cent of the total, forest cordwood forms 20 per cent, and mill waste forms 10 per cent At present there are twenty-eight active mills in the Northwest (Table 19), annually converting approximately 2 million cords of wood into 1¼ million tons of pulp. This product varies all the way from groundwood to the most refined type of pulp used in rayon manufacture The paper products include coarse wrapping, fiberboard, bag paper, newsprint, writing paper, toweling, fruit wraps, and the finest of tissue papers. This industry started in 1866 with the establishment of a rag and straw mill at Salem, Oregon, and has grown rapidly during the past twenty years, coincident with the use of hemlock wood as a major raw material

TABLE 19

NUMBER AND AGGREGATE CAPACITY, IN TONS PER 24 HOURS, OF PULP AND PAPER MILLS, 1939

State	Pulp Mills										Paper Mills	
	Sulphate		Sulphite		Soda		Mechanical		Total			
	Number	Capacity	Number	Capacity	Number	Capacity	Number	Capacity	Number	Capacity	Number	Capacity
Oregon	1	150	6	540			3	685	8*	1,375	5	930
Washington	3	785	14	3,038	1	60	8	710	20*	4,593	15	2,147
Total †	4	935	20	3,578	1	60	11	1,395	28*	5,968	20	3,077

* Some plants use more than one process

† No pulp or paper plants in Idaho, Montana, or Wyoming.

The pulp industry can and does to a limited extent draw upon the balsam firs. These species produce a pulp similar to that obtainable from western hemlock but must be processed under different conditions, hence are not mixed with hemlock in the highest grades of pulp. Some of the balsam firs, especially noble fir, are manufactured into lumber because of the high proportions of clear lumber yielded. Other species are used in the manufacture of lumber for house building, but are not looked upon favorably by many lumbermen because of the tendency to warp during seasoning and because trees over two feet in diameter are likely to be defective.

Sitka spruce is used by the pulp industry, though in limited amounts The large trees yield clear lumber suitable for specialty products, such as airplanes, in which it is used in place of metal for struts, wingbeams, etc., because it combines strength with light weight, and in piano sounding boards, where its resonance is valuable, and in insulation for mechanical refrigerators, where its light weight is desirable The major part of the clear lumber produced goes into these and similar products; the remainder is absorbed by the box industry Within recent years the production of veneer sliced from clear timbers for the construction of cheese boxes has grown to be a sizable industry providing additional labor outlets and closer utilization.

Cedar. Western red cedar, a species occurring in several of the Pacific Northwest forest types, is another specialty wood. It is often logged selectively, being cut prior to the other species in the stand because of its tendency to break and shatter. In small sizes the trees are converted into poles and piling, large trees go to lumber mills, if free from knots, and to shingle mills if knotty. The production of lumber from western red cedar averages approximately 100 million board feet annually, and the output is used mainly for house siding, in boat construction, and for caskets and coffins Whereas in the neighborhood of 95 million board feet of logs are consumed by the lumber industry, the shingle industry requires 490 million board feet annually to supply its 289 mills in Oregon and Washington. Some of these mills are large and are operated in conjunction with sawmills These buy their raw materials in the form of logs, usually on the open log market But there are numerous small shingle mills operated by a few men and frequently only part time. They purchase their raw material in the form of bolts or short logs from ranchers or small loggers and provide an outlet for timber from small ownerships, from cut-over land, and from burned areas

Associated with the Douglas fir in the southwestern corner of Oregon

FIG. 86. *Upper left:* mature western white pine. *Upper right:* lodgepole pine. *Lower.* a central Oregon lumber mill.

is an extremely valuable tree, the Port Orford white cedar. This species is logged independently of the associated species, and is used in industries centering around Coos Bay and producing battery separator plates and Venetian blind slats, or is exported to the Orient in log form. For both these products Port Orford white cedar has become the standard against which other species are compared. Battery separator stock is obtained by slicing selected blocks, Venetian blind stock is obtained by sawing timber.

Hardwoods. Growing within the West Coast Subregion are several hardwood species, no one of which approaches the softwood species in importance, but each of which contributes its bit to the welfare of the region. Most important is red alder, the principal wood used in the furniture industry of Oregon and Washington, which employs 4,000 and has an annual output valued at $13,400,000. Black cottonwood is used for pulpwood, core stock in the furniture industry, and excelsior. Oregon white oak, maple, alder, and Oregon ash are used for fuelwood, maple is used for furniture. Oak is also used for handle stock and insulator pins. Oregon myrtle is used for novelties and myrtle and maple burls were exported for manufacture of fancy veneers prior to the European War.

Intermountain and Northern Rocky Mountain Forests

The Intermountain Subregion, a high plateau with mountainous outcrops, is contrasted to the West Coast Subregion by a more arid climate and by the preponderance of pine instead of Douglas fir.

Much of the terrain on which ponderosa pine is of greatest commercial size is relatively level and unbroken—a veritable paradise for the logger in compariso with conditions encountered in the Douglas fir belt. In early logging days horses were the "motive power" most used. Logs were either skidded to the landings by horses, or were bunched by horses and the loads were taken to the landings by horse-drawn "high wheels" or carts. The powerful steam skidders of the Douglas fir region were occasionally used, but never became an important or characteristic part of pine-logging equipment. The trees and logs in pine do not attain the large diameters of Douglas fir, and the industry has tended to produce short logs (seldom over 32 feet, and of late years often 16 feet in length). This, coupled with the lighter volumes per acre, has made massive equipment less economical. Because light equipment has been used the damage to residual stands has been much less, though there are many evidences of destructive clear cutting followed by fires, areas whereon a new forest can be established only by planting.

From the horse-drawn equipment it was but a short step, requiring little imagination, to the substitution of caterpillar tractors as a motive force, first, the light agricultural tractors replacing horses on the farms, later, the heavier, sturdier, more powerful tractors developed especially for and with the help of the logging industry. These are now used almost exclusively in skidding logs to landings, in road construction with the aid of a bulldozer blade, and are even replacing trucks in hauling logs short distances to the mill pond.

Railroads are still used on the larger operations, especially those which have been in operation many years and whose timber supplies are now at long distances from the mill. But on such operations the tendency is toward the installation of less spur trackage and an increased skidding distance because of the efficiency of tractors. All the smaller mills and most of the recently installed large mills are dependent entirely upon logs hauled by automobile trucks.

Since the early days of the industry when clear cutting was practiced, the industry has tended to cut to a "zero margin," i.e., taking every tree which they considered would pay its way. The margin was usually based upon a minimum tree diameter which has varied from 12 to 20 inches, averaging around 16 inches, depending upon the operator's idea of what he could profitably manufacture under the current costs and lumber selling prices. Within the past five years there has been a tendency to appraise tree values more accurately, to cut only those with high present values and low earning power, and to leave trees whose growth rates indicate that they will earn a fair rate of interest. In this analysis the industry has been aided by economic studies conducted by the U. S. Forest Service. The result has been the gradual introduction of a so-called maturity system of selection which where rigidly applied results in the removal of 40 to 60 per cent of the volume and better than 80 per cent of the present values in a stand. This system is being applied by some lumbermen, especially where private timber is being operated in conjunction with national forest timber.

Uses of Ponderosa Pine. Lumber manufacture in the ponderosa pine region has developed from small mills designed to produce local construction and box lumber, to larger mills catering to the demand for boxes created by the California fruit industry, and to large well-equipped mills producing carefully manufactured lumber to be shipped throughout the country The early mills cut largely box lumber, the whole output was air-dried, there was a minimum of segregation into grades and but little remanufacture, and the trade territory was limited in extent Small mills are still operating in this manner. At the other

extreme is the large, well-equipped mill, cutting for the highest return, kiln-drying its entire output, obtaining the best grade recovery, and shipping throughout the United States.

Associated with some of the mills are remanufacturing plants engaged in the production of box shook, sash and door cuttings, and numerous other products. In this way more local labor is employed and more intensive utilization is assured Dependent upon ponderosa pine mills are two especially large industries, the box industry and the sash and door industry. The former provides an outlet for the lower grades of lumber, the latter an outlet for the so-called cutting grades The clear grades are used in some remanufactured products and in moldings and are sold for finish lumber in construction.

Within the past few years the production of plywood and veneer from ponderosa pine and the associated sugar pine has become established This provides a limited, though apparently increasing, outlet for the large clear logs. Veneer and plywood plants as far away as Vancouver and Aberdeen, Washington, are competing with inland plants for the supply of pine "peelers"

In its logging and manufacturing the Northern Rocky Mountain Subregion resembles most closely the Intermountain Subregion. The terrain is rougher and the main species is western white pine, though ponderosa pine appears as a prominent species Logging has followed the same trends noted for the Intermountain Subregion—horse logging followed by tractor logging on favorable terrain—whereas at higher elevations logs were and to a decreasing extent still are transported down hill by chutes. In several of the larger streams log drives are common, resembling the transportation method made famous by the Maine and Lake States white pine loggers

White Pine and Other Species Western white pine, the leading species in this subregion, resembles closely the eastern white pine in properties and uses The latter species has been widely used since colonial days It formed the basis of the ship-building industry of New England and was the foundation of the lumber industry from Maine to Minnesota Largely a tree of the past, its markets are now being filled to a great extent by its western cousin.

Western white pine, a highly valuable wood, is used for high-grade finish lumber, sash and doors, patterns, all kinds of millwork, matches, box shook, crating, and many specialty uses Its principal associates, western larch, Douglas fir, ponderosa pine, and white fir, are used for common building lumber. Larch is also used for ties, siding, and posts.

Ponderosa pine as in the Intermountain Subregion has a variety of other uses.

Cedar poles, an important product of this subregion, are shipped to many parts of the country.

Local copper and coal mines form an important market for lower-grade material in the form of round timbers and sawed timber and lumber for converter poles, props, stulls, and other items

To gain a true picture of the importance of wood products in the economic life of the region, the part played by the small sawmill and by wood and pole or post cutting operations must be realized Farms, stock ranches, and small communities need and use large amounts of wood for lumber, poles, posts, and fuel. A considerable portion of the rural population of the region uses wood exclusively for fuel. In many cases these products are obtained cheaply from local stocks supplied by small local lumbering operations Frequently the farmer supplies his own fuel, posts, and poles with no direct cash outlay. This is especially important where small farms are operated on a close cash margin. Further, the small woods operations often provide supplemental employment and cash income for farmers in or near the forests. The numerous little mills and timber or fuel cutting operations, scattered inconspicuously through or around the fringe of the forests, thus constitute an industry that helps to maintain higher standards of living for many families and communities, even as the large lumbering operations do in their more obvious way

THE FUTURE OF THE PACIFIC NORTHWEST FORESTS

The future value of the forests of the Pacific Northwest will be determined by the breadth of vision and technical skill with which they are managed Wise management can make them permanently productive, lack of it can make the forest lands, most of which are unsuited for any other use than forest production, social and economic liabilities rather than assets.

Sustained Yield, Regional and Local

In very general terms, sustained yield can be defined as a condition under which forest depletion from all causes does not exceed a reasonably satisfactory rate of forest growth It is analogous to the prudent use of invested capital, whereby only the interest is withdrawn for current income and the capital is maintained intact to earn more interest. The forest itself is the capital and the growth is the interest The true purpose of sustained yield is deeper than the important one of supply-

ing permanently the lumber and other forms of wood needed by the nation. It must also serve as the economic basis for permanent prosperity of the many people who derive their living from woods work, and of the large and small communities within which they live

Were the continuity of wood supply the only objective of sustained yield, it might be possible to divide the commercial forests of the Pacific Northwest into an arbitrary number of very large operating areas, such as four, confine lumbering operations to one of these four areas for twenty-five years and then move all those operations to the next one, thus progressing from one to the other If proper forestry measures were applied, a new forest would have grown on the first area when lumbering operations on the fourth one had been completed, and the lumbering operations could thus return to the first operating area to begin the second round. Such a procedure might insure the future wood supply because, for the region as a whole, wood would be growing as rapidly as it was cut. But this method would fail utterly to meet the broad, social objectives of sustained yield. Each of these large operating areas would experience, over the centuries, cycles of 100 years, in each of which there would be 25 years of humming activity and prosperity while cutting was under way and 75 years of economic stagnation while the new forest was growing.

To attain its social objective the principle of sustained yield must be applied locally. Each forest area upon which one or several communities are dependent must set up a balance of satisfactory forest growth and depletion in order that those communities may be assured permanently of the raw material in the form of wood to support their local dependent industries. Even a regional balance between growth and depletion can be attained at a heavy cost to local communities The presence of great areas of old-growth timber or nearly mature growing forests in the Blue Mountains or in southwestern Oregon could not maintain a community on the Puget Sound dependent upon one or more sawmills, if all the near-by timber had been cut.

Forest Protection

A complete plan of forest management in the Pacific Northwest will include as of primary importance better forest protection. Forests always face three great enemies—fire, insects, and disease. At the present time considerable areas of forest land are being burned over each year. These fires cause an immediate economic loss when merchantable timber, logs ready for market, logging equipment, and in many cases other valuable property are destroyed There is also the

annual destruction of large acreages of immature timber or seedling forest growth, much of it too young to have immediate conversion value but constituting the future timber supply

More than half of these fires are man caused and are therefore preventable. Smokers, campers, picnickers, land clearers, hunters, and fishermen are responsible for many. Others are started in the course of logging operations, and although smaller in number they frequently result in relatively large losses because of their incidence near mature timber.

Many insects are parasitic on the forest tree species which occur in the Pacific Northwest. The infestation of a certain number of these parasitic insects is sufficiently extensive and destructive to constitute a serious threat to continued forest production in some parts of the Region. The outstanding offenders are a group of insects known as the bark beetles. For the past two decades the infestation of the western pine beetle in the ponderosa pine forests of the Region has been particularly serious. The losses from the attacks of this insect have in many years exceeded the volume of timber harvested Other species of bark beetles attack Douglas fir in the West Coast Subregion and the western white pine and lodgepole pine. Control of these insects is affected by felling the infested trees while the insects are under the bark in the larval stage and removing and destroying the bark prior to the natural emergence of the insect Numerous other species of insects attack forest trees in this region, but losses have not been so serious as those from the bark beetles.

Fungous diseases of various types take a constant and heavy toll in the forest The wood-rotting fungi are constantly at work, particularly in the older, more valuable forests It is largely through the action of the wood-rotting fungi that natural depletion in the virgin forests of the Region offsets growth No direct method of control is known to be feasible Future forestry operations, however, involving the cutting of younger trees than now occur in our virgin forests, will doubtless decrease the losses from such fungi.

Serious forest tree diseases of an epidemic nature are known to exist in various parts of the world. Thus far only one of these is known to occur in the Pacific Northwest White pine blister rust, a native of the European Continent, was introduced in the Pacific Northwest in 1910 and since then has spread over almost all the range of western white pine within the region Because of the relatively slow rate of progress of the disease in mature trees, relatively little loss of merchantable timber has thus far been experienced Heavy losses are to be expected

in reserve stands of merchantable timber in the future unless the disease is controlled. Losses are now occurring at an alarming rate in very young stands of western white pine. Control of the disease is by removal of its alternate host, or nurse plant, wild currants and gooseberries, from those parts of the forest where the white pine should be protected An extensive program for the control of the disease on a co-operative basis between the federal government, the states, and private interests is now under way.

Methods of Cutting

The preceding discussion of forest growth and depletion indicates that no net growth will occur in most old virgin forests because the rate of natural depletion equals the rate of gross growth. If the forests of the Pacific Northwest are to be used permanently for timber production, they must continue to grow so that new wood material will be formed to replace that which is removed. One of the difficult and perplexing problems of forest management in the Pacific Northwest is to convert the old virgin forests, static as to growth, into growing forests This can be done, of course, through removal by logging of the old forest stand, if this removal is followed within a reasonable period by the appearance of a young and thrifty forest Removal of the entire forest stand, known as clear cutting, has been practiced over large areas in the past. Subsequent fires and dearth of an adequate seed supply have transformed many of these previously clear cut areas into brush fields rather than young forests Recently developed methods of cutting, largely made possible by the development of new types of machinery, involve the removal of only portions of the forest cover This process is known under the general heading of selective cutting Its effect upon the rate of growth and general health of the remaining forest stand and upon the species composition of the future forest is as yet not fully understood Such questions will be answered only by forest research and much added experience in the application of these methods It now seems probable, however, that they will be highly successful in certain types of forests and less so in others They are particularly suited to forests known to the forester as uneven aged, that is, where trees of all ages are intermingled. In such forests the removal of the oldest trees releases added plant food and sunlight to the remaining trees, and very frequently results in a most satisfactory increase in the rate of growth.

The problems confronting the forester in his efforts to convert the old-growth forests of the Pacific Northwest into growing forests are

highly technical and complex, both in the fields of biotics and economics. Their solution, however, is of paramount importance to the continuance of the forest industries of the region

Need for Better Utilization

Existing economic conditions make it impossible to log all species of forest trees and all classes of forest material at a profit. This situation results in the waste of large amounts of materials which must be left in the woods It furthermore sets up a dangerous condition on the cut-over lands because the material left behind becomes highly inflammable and increases the danger of forest fires More complete use of forest materials from the forests of the Pacific Northwest will doubtless occur in the future through betterment of economic conditions, combined with technical research which will find new uses for these materials As such better utilization occurs, it will aid materially in the solution of many of the technical problems now faced by the forester.

Forest Land Ownership and Taxation

The preceding discussion of land ownership in the forests of the Pacific Northwest indicates the obstacles presented to sound forest management by a land ownership system which does not normally provide for unified, or at least highly co-operative, ownerships within a single management unit. Many practices which would directly benefit the long-continued use of production of these forests can be put into effect only over an operating unit as a whole Failure of part of the owners within such an operating unit to take action will nullify the efforts of others who might be desirous of putting such practices in effect It is, therefore, probable that many improvements in forest practices can be instituted only when the intricate patterns of forest land ownership are resolved into simpler ones. Furthermore, there is the question of division of forest land ownership between private agencies or individuals on the one hand and the public agencies, federal, state, county, and municipal, on the other hand, because good forest development will be furthered by a determination of the most effective degree of ownership by these various agencies and the acquisition of forest lands by these various agencies in accordance with a recognized formula and pattern. There is, also, need of federal, and in many cases state, legislation to permit the establishment of sustained yield units upon a long-time co-operative basis between public and private agencies. Such legislation, with long-time contracts drawn up as a result, will enable

private capital to make necessary investments to harvest publicly owned timber together with its own, in accordance with the general principle of sustained yield operation that the rate of cutting shall not exceed the rate of growth.

The problem of equitable taxation of forest lands, old-growth mature timber, and young growing forests, is a complex and vexing one. It is now generally agreed that the application of the customary ad valorem tax without any adjustments for the length of time necessary to grow a timber crop does not favor the holding of forest land and the development of good forest practices by private enterprise.

Lastly, there must develop in the public conscience realization of the part which the forests of the Pacific Northwest play in the economic and social life of the region. It is only by realization of these relationships that public opinion can be enlisted in the cause of forest fire prevention and the solution of the many technical, biotic, and economic problems which must be solved if the forests are to play their permanent and proper part in the life of the Region.

Summary of Conditions and Problems

The present condition of the forests of the Pacific Northwest and the physical and economic problems which must be solved if these forests are to continue to make their full contribution to the economic life of the Region can be summarized as follows·

1 Seventy-five million acres, or 40 per cent of the area, are commercial forest land, primarily suited to the growing of timber Another 24 million acres, or nearly 13 per cent of the total area, are noncommercial forest land, valuable for watershed protection, wildlife habitat, grazing, and recreation Very little of this land is suitable for other uses.

2 Wood-using industries, deriving their raw materials from the commercial forest lands, manufacture products valued at over one-half billion dollars annually, and provide employment to 118,000 workers who are paid wages of nearly 150 million dollars a year

3 Wood-using industries are now based almost entirely upon virgin forests, these have been removed from over 35 million acres, or 48 per cent of the commercial forest area When the remainder is cut the industry will become dependent upon second-growth forests

4 Of the 35 million acres from which the virgin forest has been removed, more than 9 million acres, or over 25 per cent, now bear no second growth, or the growth is too sparse to form a satisfactory commercial forest

5 A sound forest program for the future should include

A. More adequate protection from fire, insects, and disease

B Methods of cutting which will insure better forest reproduction.

C Public ownership or responsible private ownership which can guarantee management for continued production

D Practicable processes by which a greater proportion of the forest raw material can be utilized and marketed in the future

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CHAPTER 12

WILDLIFE AND ITS CONSERVATION IN THE NORTHWEST

By William L. Finley and Irene Finley

Conservation of wildlife is concerned with the proper use rather than the misuse of this natural resource As population has increased from the Atlantic to the Pacific, land and water resources have been used more and more for economic and commercial purposes, such as the fencing and plowing of prairies and valleys, the cutting of forests, and the damming of rivers. These changes have had an effect on all our wildlife species. Moreover, as the country developed, an increasing number of people hunted the birds and mammals and angled for the fish, which further affected the various wildlife species Even with the increase of population, the Pacific Northwest still has great wilderness areas in the Cascades, Rocky Mountains, and Coast Ranges, with their extensive forests and snow-clad mountains. The birds and mammals have inhabited them for thousands of years, and through the ages different species have become closely adjusted to their environments The conservation of native wildlife is directly related to the maintenance of these natural habitats which in turn are benefited by the conservation of forests, grasslands, and water resources.

It is the general opinion that in the early days, fish, birds, and mammals were very abundant throughout the Pacific Northwest. There is every reason to believe that increase of population and the killing by fishermen and sportsmen have greatly reduced wildlife numbers This is undoubtedly true in some sections It is also true that, in certain places, game birds, mammals, and fish were not found in earlier days. The artificial propagation and the introduction of species adapted to these areas have furnished game or fish where they were not found before.

Fresh-Water Fish

Among the fresh-water game fish, the best known in the Pacific Northwest are the cutthroat and rainbow trout The Pacific Northwest has several distinctive and valuable kinds of game fish Its geological position and environment, with many tidewater streams, have created

the wonderful steelhead or rainbow trout. The rainbow is a beautiful, gamy fish that lives throughout the year in the upper stretches of many mountain rivers The steelhead is a sea-run rainbow that, for some ancestral reason, migrates to the sea and develops to a size of ten to twenty pounds before it returns to fresh water to spawn

The Clark trout, commonly called cutthroat, was first described by Captain William Clark of the Lewis and Clark Expedition This, like the rainbow, has a divided family, a part migrating to the sea and returning and the other staying in fresh water all the year. The lamprey, another migratory fish, somewhat resembles an eel in its habits. The Dolly Varden is also a species found in northwestern waters, but, as it has the predatory habit of living on other fish, it has not been propagated in hatcheries, and no effort has been made to increase its numbers

Other fresh-water game fish in the Pacific Northwest are the whitefish and graylings Huge sturgeon occur in some of the deeper rivers. Lake trout, several kinds of bass, and other species have also been introduced

The question arises as to natural and artificial propagation of the game fish in nearly all our streams. Both these plans have a definite place in the present and future of our game-fish population Both are important. In many places, however, little attention has been paid to the natural spawning beds although all efforts have been extended to hatcheries and artificial propagation

In accordance with their natural requirements, certain species like the cutthroat and the rainbow are the inhabitants of streams because the food and water conditions are favorable For this reason, every effort should be made to protect and hold the balance of fish in such waters In too many cases fish wardens have lacked the necessary scientific training for successful game-fish propagation Unless careful studies are made, fish commissions may hatch and bring in species from other regions to liberate in northwestern waters, when they do not really know whether the introduced species are those that can survive, or whether they will interfere with the native fish. Certain streams adapted to cutthroats have been stocked with bass, crappies, perch, and other species that do not belong there. Any student of natural history knows that a trout survives only where conditions are favorable

In many rivers where the native species have decreased and complaints have been made by anglers that fishing is poor, the game authorities, who receive their money from such fishermen, follow the plan of providing anything that the sportsmen can catch Instead of

scientific stocking with proper species, millions of fingerlings, both native and foreign, have been poured into streams without investigating the supply of insect and other food or the permanent results that may follow. Some fish commissioners take the attitude that a fish is a fish, then plant anything that is available, without really knowing whether or not it is suitable.

Waterfowl

Originally the Northwest possessed considerable areas of swamps and lakes suitable for nesting and resting places of migratory waterfowl One of the main migration routes for birds from the far north summer breeding grounds to the California and Mexican winter feeding areas passed over the Pacific Northwest, some of the flocks going east and some west of the Cascades Many of the feeding grounds of waterfowl have been drained and otherwise destroyed The ill-advised drainage of Lower Klamath Lake is a case in point, where part of the former lake bed and marshes that were the resort of myriads of waterfowl has become an alkali waste In addition, hunting and injury to the breeding places lessened the numbers of the breeding stock, causing large decreases in numbers of birds

In regard to migratory waterfowl, it was for a long time impossible to get different states to pass effective laws for their protection. One of the first and most important steps was the Migratory Bird Treaty made by Great Britain and the United States, and ratified December 7, 1916. After the several years required to get this treaty adopted, the necessary Enabling Act was not passed, to receive the signature of President Wilson, until July 3, 1918 This ended the wholesale shooting of ducks and geese and made the sale of wild fowl illegal in the United States.

Even though the killing of migratory waterfowl was controlled, these birds still declined in numbers because of the change in breeding and feeding conditions. Many of the nesting places were destroyed, and birds, like the canvas-back and the redhead ducks, greatly decreased in the Pacific Northwest During the past few years, more efforts have been made to restore breeding areas. The stopping of spring shooting, forbidding the baiting of ducks where they are hunted, and the shortening of seasons and bag limits have helped restore the numbers of certain species The former United States Biological Survey, in conjunction with the game commissions of our states, started the work of restoring migratory waterfowl.

The Federal Aid to Wildlife Restoration Act was passed in 1937 This act is of vital importance, because it enables the Fish and Wild-

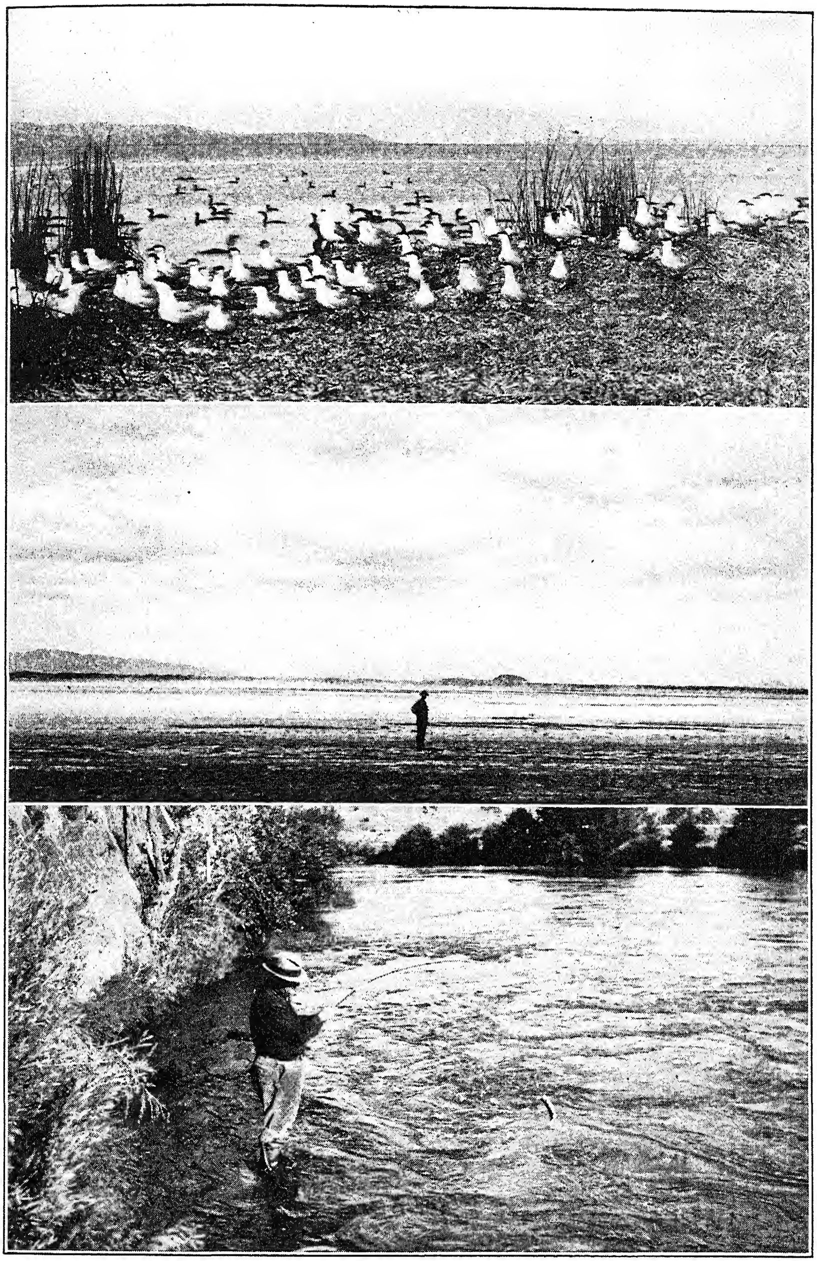

Fig. 87. *Upper:* colony of Caspian terns and Farallon cormorants in Lower Klamath Lake, one of the largest wild bird refuges, established by Theodore Roosevelt, 1908. Photograph taken in 1905.

Middle: Lower Klamath Lake deprived of water and changed to an alkali desert, devoid of life. Photograph taken in 1935.

Lower: angling in the Deschutes River.

(*All photographs by William L. Finley.*)

life Service of the Department of the Interior to co-operate with different states in scientific research and establishment of reservations for wildlife protection. Under this law many migratory bird refuges have been established. Already there has been a definite increase in various kinds of waterfowl, such as mallards, pintails, and widgeons, the most abundant species in the Pacific Northwest. Red Rock Lakes Migratory Waterfowl Refuge in southwestern Montana protects the swans in one of their few remaining breeding grounds.

Upland Game Birds

The topography of the Pacific Northwest and its climatic conditions are varied. The whole coastal belt is heavily timbered, with the Coast Range running north and south. To the east are big and little valleys with rich soil for agricultural development Farther east is the higher range of the Cascades, extending north and south through the center of Oregon and Washington This whole area is also heavily timbered and pointed here and there with snow-capped peaks. Beyond the Cascades to the east is a basin high in altitude and dry in climate, with wide open stretches of sagebrush; but along all the larger waterways and their tributaries are fertile valleys and farmland In this widely varied Northwest no human expert could have planned such a remarkable and finely distributed display of upland game birds as nature has provided. The variations of species were developed through long ages according to adaptation, environment, and food supply

Originally this whole Region was populated with various species of upland game There were six species of the grouse family. The most abundant bird through the extensive wooded country was commonly called the blue or sooty grouse, a species inhabiting the fir forests from California to Alaska. The sooty grouse, dark or sooty blue in color, varied a little from the Richardson grouse east of the Cascade Range, where climatic conditions produce feathered coats lighter in color Like the wild turkey this grouse is a bird of distinct and particular interest. During the spring and early summer the male has an accustomed hooting place. The yellow pouches on his neck are inflated, and, with tail spread and wings hanging, he produces a series of hoots, ventriloquistic in character The call may seem half a mile away, while actually coming from the top of a tall fir near by.

The ruffed grouse is also characteristic of the wooded areas of the Northwest. A bird of the humid coastal belt, it is dressed in rich red-brown, which is replaced by a distinctive gray coat in the higher and drier areas. In logged-off areas where maples and alders replace the firs,

and in the wild crabapple and ash thickets, this used to be an abundant species. The elongated black feathers on the sides of the neck, forming a ruff, identify the cock. The drumming of the male, standing erect on a fallen log and striking the air with his wings, was a sound familiar to every old sportsman.

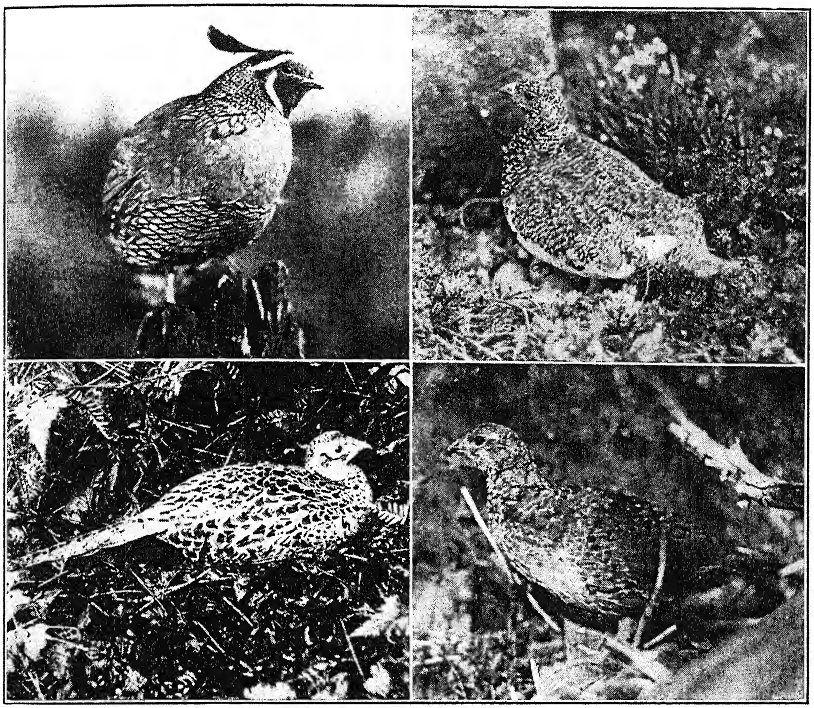

Fig. 88. Birds of the Northwest.
Upper left: California or valley quail.
Upper right: female white-tailed ptarmigan at nest.
Lower left: female Chinese pheasant.
Lower right: sooty or blue grouse.
(*Photographs by William L. and Irene Finley.*)

The Franklin grouse is another game bird of the Cascade Mountains; it ranges to the north and east. It is even more distinctive in character than the ruffed grouse. For some reason it is utterly indifferent to the approach of man, and will scarcely move out of the trail. If you approach slowly it is often possible to pick up one of these wild birds in your hand. That it shows no fear and that any woodsman can knock its head off with a stick have given it the name "fool hen."

The white-tailed ptarmigan or "snow grouse" is a bird created for and adapted to higher altitudes Most remarkable is its change of coats with the seasons, a well-known example of adaptive or protective coloration A dress mottled with black and brown for the summer or breeding period is shed and replaced by one of pure white when the snowy period arrives Although a former resident of snow-capped peaks in Oregon, this bird has disappeared there, but still lives on the slopes of Mt. St Helens, Mt. Adams, and Mt Rainier in Washington.

In eastern Oregon and Washington sportsmen formerly were accustomed to flush a flock of pale brown grouse from the meadow lands and watch them fly off with a "Kuk! Kuk!" of alarm These were the Columbian sharp-tailed grouse. Perhaps no bird offered more tempting sport to hunters because, like the prairie chicken farther east, it was a bird of the more open country.

Every section of the Pacific Northwest varying in its flora is the home of a particular species of grouse. Perhaps the most distinctive of all are the open sagebrush stretches where the pines and even the junipers have played out, leaving wide reaches of sand and gray sage Here nature has created the largest and most stately grouse of America, commonly called sage hen The weight of a sage cock may be anywhere from five to eight pounds. His tail is long with narrow, pointed feathers. In the spring he struts somewhat like a turkey gobbler, with fan-shaped tail spread and air sacs inflated, giving his breast a balloon-like appearance

As if nature had not been lavish enough in its supply of upland game in the Pacific Northwest, she furnished two remarkable species of quail The mountain or plumed quail flocked through the wooded areas of western Oregon and Washington. This bird is distinguished by the long, slender, erect plume feathers on the head and the rich, mottled, chestnut coloring of its sides, whereas the flanks were banded with black and white.

A second species, called the California, little blue, or valley quail had a very different topknot that curved forward above his bill His black throat, encircled by white, and the scalelike appearance of the breast feathers, easily distinguished him from any other species. This species was a native of southern Oregon, but is now common in other parts of Oregon and Washington.

The bobwhite quail, a bird of the East, has been introduced into many other parts of the country. It is now abundant in the fields of the Pacific Northwest. It does not, like the mountain quail, live so

much in the wilder sections but is found in farming areas, where it holds its own like the California quail

The ring-necked or Chinese pheasant was introduced into Oregon in 1881 It spread rapidly in the Willamette Valley in such numbers that later thousands of them were killed each season Then after about thirty years conditions changed and the birds began to decrease in number in the Willamette Valley They were introduced in many other parts of the Pacific Northwest, and they are now far more abundant in Eastern Oregon, Washington, and Idaho than in the western parts of Oregon and Washington. Because these birds seem to be more available for sportsmen, the Game Commissions have spent large amounts of money in game farms Many thousands are raised and released each year, thus furnishing game for the sportsmen to shoot when the season is closed in many places on grouse and quail Hundreds of thousands of dollars have been spent to propagate these pheasants, European or Hungarian partridges, and other foreign birds. Practically nothing has been expended to study the decrease of our native grouse and quail and try to prevent their extermination

In addition to the sportsmen, nature lovers are vitally interested in wildlife conservation, and farmers desire the preservation of many species of birds which help control insect pests and weed seeds detrimental to gardens, farms, and forests In addition to the song birds that are helpful to man, most of the hawks and owls destroy mice, ground squirrels, etc, that may damage crops and other vegetation Only a very few predatory birds do more harm than good The upland game birds and song birds need suitable habitats for feeding and nesting, many of the places once used have been destroyed or modified by man. Bird life can be restored best by providing improved environments that meet the needs of various species

Big Game

Three kinds of deer inhabit the Region. The Columbian blacktail, found west of the Cascade Range, is more a resident of the forested areas, where it has abundant summer and winter food supplies The deer browses largely on the leaves of lower limbs and bushes

The western white-tailed deer was formerly common in Oregon, but with the increase of population it disappeared entirely from the Willamette Valley foothills. A few have been reported in Douglas County on the west side of the Cascades and the foresters have reported twenty or thirty that still live in the Davis Lake region of Crook County on the east slope

East of the Cascade Range is a large species, called mule deer A most surprising feature is the large increase in these animals during the last few years They have spread out and occupy areas where they were not formerly found Years ago in Oregon most deer hunting was west of the Cascades, but today it is largely east of the mountains Because of the increasing number of hunters, it was thought the deer would decrease more and more, but instead they have been increasing Perhaps one of the reasons for the increase of deer in the east has been the killing of predatory animals, such as the coyote, bobcat, and mountain lion The summer food supply is abundant, but the increase in number of deer has brought the problem of winter food supply This is a problem that has been brought up partly by the use of both private and public property, especially forest areas, for the grazing of sheep and cattle Because of the increase in deer numbers, and the decrease of the winter food supply, in some areas seasons have been opened for shooting not only bucks but also does.

In regard to the elk or wapiti that inhabit the Pacific Northwest, the Roosevelt elk ranges from the Olympics south along the coast line to southern Oregon In the Olympics they have increased in numbers, also in Clatsop County, Oregon, south of the Columbia River Thirty years ago, there were comparatively few elk in eastern Oregon and Washington A few were introduced from the Jackson Hole country, more careful protection was given, and the numbers have increased to a remarkable extent At the time elk were introduced in eastern Oregon and Washington, it was thought they never would increase to such an extent that an open shooting season could be permitted During the past few years, however, thousands have been killed, and in certain areas the season has been opened on the cows.

The same condition existed in regard to the antelope or pronghorns. The largest number was formerly in southern Oregon and southern Idaho None were found in Washington, but some have now been introduced Because of the gradual increase during the past twenty or thirty years, an open season has been established in Oregon and Idaho. Several hundred are killed each season, but even so the numbers seem to have kept up fairly well. A large federal refuge has been established in the Hart Mountains in southern Oregon for the protection of antelope, mule deer, and sage grouse.

The American bison or buffalo was formerly abundant in southeastern Oregon and from the plains of the Columbia River, east, but seems to have disappeared before the arrival of white men. The

earliest settlers did not report any live buffalo in eastern Oregon or Washington, yet when Malheur Lake went dry a large number of

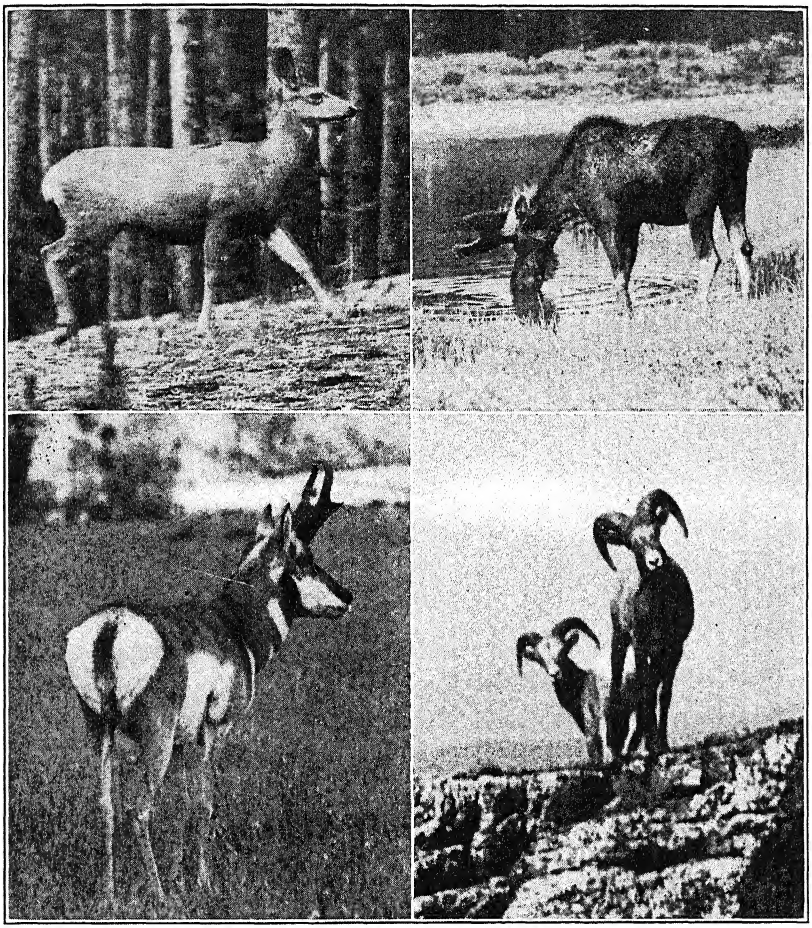

FIG. 89. Big game animals of the Pacific Northwest.
Upper left: mule deer doe, of a species abundant east of the Cascades.
Upper right: bull Shiras moose, horns still in the velvet.
Lower left: antelope or pronghorn.
Lower right: mountain sheep, or bighorn.
(*Photographs by William L. and Irene Finley.*)

buffalo skulls were found buried in the lake bed. Buffalo can be seen in Yellowstone National Park, and on the National Bison Range in Lake and Sanders counties, Montana.

The Shiras moose also has a very limited range in Idaho, Wyo-

ming, and Montana, but the numbers have been steadily increasing in Yellowstone Park.

Bighorns or mountain sheep are scarce in the Northwest. Those that formerly ranged in southeastern Oregon have been exterminated. A small number still range in the extreme northeastern part of Oregon and some in Washington, also farther east, in Idaho, Montana, and a few in Yellowstone. There has been a decrease in some areas and a slight increase in others. Recently some mountain sheep have been introduced in the Hart Mountain Refuge of southern Oregon.

The mountain goat was formerly reported in the Cascade Mountains of Oregon, but they have now entirely disappeared. They are still found, however, in the Cascades in Washington, and especially in Mt. Rainier National Park, above Lake Chelan, and farther north. A few range in Idaho and Montana. They are quite abundant in Glacier National Park.

As the population of the Pacific Northwest has increased, and the livestock range is enlarged, some big game species have held their own; but others have gradually disappeared. The only possibility, therefore, of maintaining species like the buffalo, moose, mountain sheep, and mountain goats is to have national parks or special reservations set aside.

Esthetic and Practical Values of Wildlife

Wildlife resources of the Northwest, including fish, birds, and mammals, have a certain value that should be carefully considered. It helps to attract people from other parts of the country. These visitors spend millions of dollars, and the tourist business may be regarded as an economic asset.

The rivers of the Region have multiple uses, and if possible power and irrigation developments should be carried on so that the waters are not injured for fish. Pollution of the streams by municipal and industrial wastes should be stopped, both because of fish life and for esthetic and health reasons. Although pollution of western waters has not been so excessive as the rivers of the more populous and industrialized East, the advent of pulp mills and other plants with effluents may cause damage to our streams and bays. Scientists, engineers, sociologists, and economists should all co-operate in comprehensive studies of the problem of preservation and the multiple uses of inland and coastal waters. By the application of science it should be possible to preserve and to restore where necessary the balance

of nature so that the Northwest will continue rich in wildlife as well as in other resources.

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CHAPTER 13

RECREATION AND TOURISM

By JOSEPH T HAZARD

"Whether it is a garden, a farm, or a forest, any piece of land may also yield repose and joy."

Henry A Wallace, former Secretary of Agriculture

In pioneer days leisure was hard earned and its hours were fleeting The lure of those few leisure hours was toward the settlements and towns, not away from them. The tour had not arrived, for journeys were events of necessity rather than vacation.

Now there is a daily exodus from home and office, from mart and plant, from loft and factory and farm, in the search for some kind of recreational release. The week-end trip and the longer tour have been born of the strong desire for more complete rest and relaxation, a different sort of activity, and for new and changing scenes. Recreation as a recognized part of the American way of life has been made easier by a number of modern developments

1 An average of 370 leisure and vacation hours a year above the usual hours of labor
2. Division of labor, adjustable to progressive vacations.
3. Multiple uses of city lot and country land.
4. Improved transport media
5. Income beyond subsistence needs
6. The recognized right of vacations for everyone
7. Systematic development of recreation as a major industry.

Mountains as Background for Outdoor Life

The Pacific Northwest, year by year, is developing a broadly regional identity in national recreation. No single factor in this growing recognition is more important than our mountains with their meadows and parklands, their crags and rock cleavers, their high bench lakes and waterfalls and milky torrents, their summer snowfields and winter playfields, their spurs and ranges and summits. From the Grand Tetons

west to the Olympics and from Crater Lake north to Mount Baker and the Canadian Selkirks, three distinct types of recreational penetration have developed.

1. The smooth highway, the graded trail, and the comfortable highland resort are now available to the average man.

2. The elusive fastness, the exacting snow finger or rock face, the isolated pinnacle or peak tempt the hardy and adventurous.

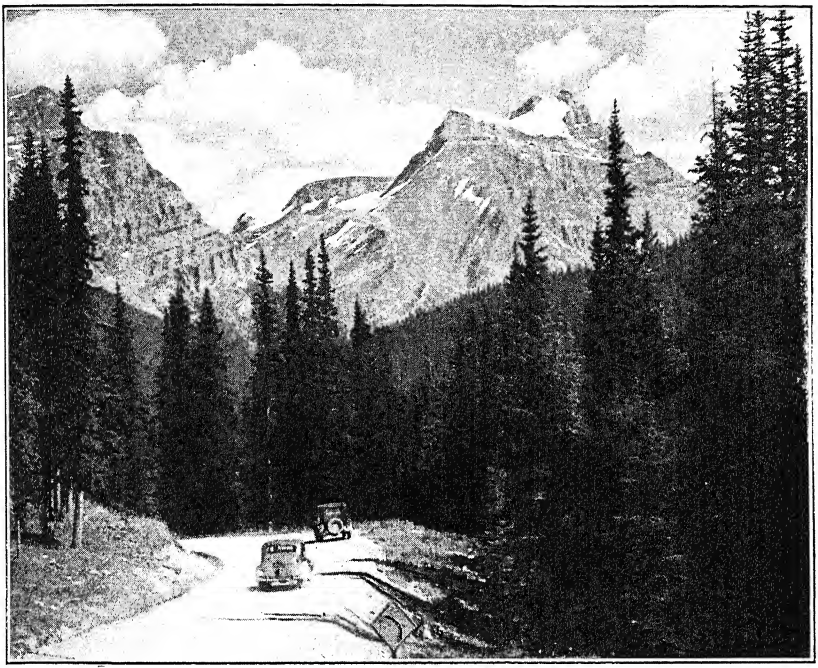

Fig. 90. On the highway between Jasper and Lake Louise in the Canadian Rockies. (*Department of Mines and Resources, Ottawa.*)

3. The winter ski resort, tucked away beside the mountain highway, nestled within the high valley pocket, or set still higher against steep slopes of the mountain, serves three types of skiers:

a. The novice and dilettante demanding lifts, hot and cold water, and a cuisine.

b. The cross-country runner who makes the resort merely a starting point from which he ventures ever deeper into untamed snows, with meager food and camp on his back.

c. The contest skier, defiant of the laws of gravity, whose records and achievements are followed by increasing thousands.

The Climatic Factor, Winter and Summer

Climatic variations in the Pacific Northwest have their distinct influence on both summer and winter recreations.

Western Montana has two main regions for recreation, based upon summer and winter influences of climate:

1. The wind-swept eastern Rockies, embattled by Polar air masses in winter, are climatically severe for winter sport but attractive for summer trails and camps. Glacier Park lies within this region.

FIG. 91. The Many Glacier region in Glacier National Park. (*Photograph by T. J. Hileman.*)

2. Within and behind the Rockies the severities of Montana's continental climate are tamed by the modifying influences of protecting mountains. Missoula and Kalispell, at the confluence of mountain valleys, have good conditions for winter recreation. Cool summer trails lead to a complexity of higher valleys well served by private resorts and forest camps.

Northwestern Wyoming has interior continental climate made more extreme by high altitude. It is an ideal summer vacation region, but its winters are so severe that most of the summer population leaves.

Idaho has two distinct climates and a zone of transition:

1. Northern and central Idaho have a continental climate modified by

protective mountains Central Idaho is mainly inaccessible except in summer, when its deep canyons, high forests, rugged ranges, clear lakes, and rushing rivers appeal to the exploring and adventuring type of men The deep canyons of the Snake and the Salmon rivers offer great possibilities for future recreational development in sections where large game flourishes almost undisturbed.

2 The mountains of south-central Idaho lie between the modified continental climate and the steppes to the south Here is Sun Valley, Payette Lakes, and other winter and summer resorts The arid steppes blend into the watered mountains, long northern reaches of plateau and range temper the cold from the northern continent, southern exposures promote climatic mildness, recreation finds a real home, winter and summer

3. Southern Idaho, with its steppe climate, is generally unfavorable to outdoor recreation, except at local resorts near cities

Western Washington and Oregon are essentially similar in climatic adjustments. West of the Cascades the climate is temperate marine, except where modified by relief features Recreation is affected by the variable weather conditions, and the thousands of local weather pockets in western Washington and Oregon add spice and variety to recreational adjustment In spite of winter rains this mild climate is conducive to a twelve months' program of recreation.

Eastern Washington and Oregon, east of the Cascades, has a special type of steppe climate that is greatly modified by altitude and its position relative to the surrounding mountains. Lake and mountain resorts are favorites for summer vacations. Winter sports are carried on at Mt. Spokane and in the Blue Mountains.

Ocean, Lake, and Stream

Another recreational asset, added to those of topography and climate, is found in the water lanes of ocean and sound, of lake and stream, throughout the entire Pacific Northwest. Blocked drainage, the aftermath of glaciation, has left thousands of mountain lakes, both great and small, from near sea level to the shoulders of high mountains, in western Montana, northeastern Wyoming, northern Idaho and Washington, central Idaho and Oregon. Rivers and rivulets, streamlets and mountain rills loiter along the valleys, dash down slopes in a white foam, or cascade over cliffs and mountain walls. By far the greater number are recreational or can be made so.

Protected saltwater sounds and bays are plentiful along the North Pacific littoral, especially north of the Columbia River Willapa Bay, Grays Harbor, the Strait of Juan de Fuca, Haro Strait, Puget Sound, Georgia Strait, and the Inland Passage to Alaska give thousands of

square miles of inland salt waters. Both the waterways and the shores of the Region, with their long gentle beaches and picturesque headlands, are attractive to pleasure seekers.

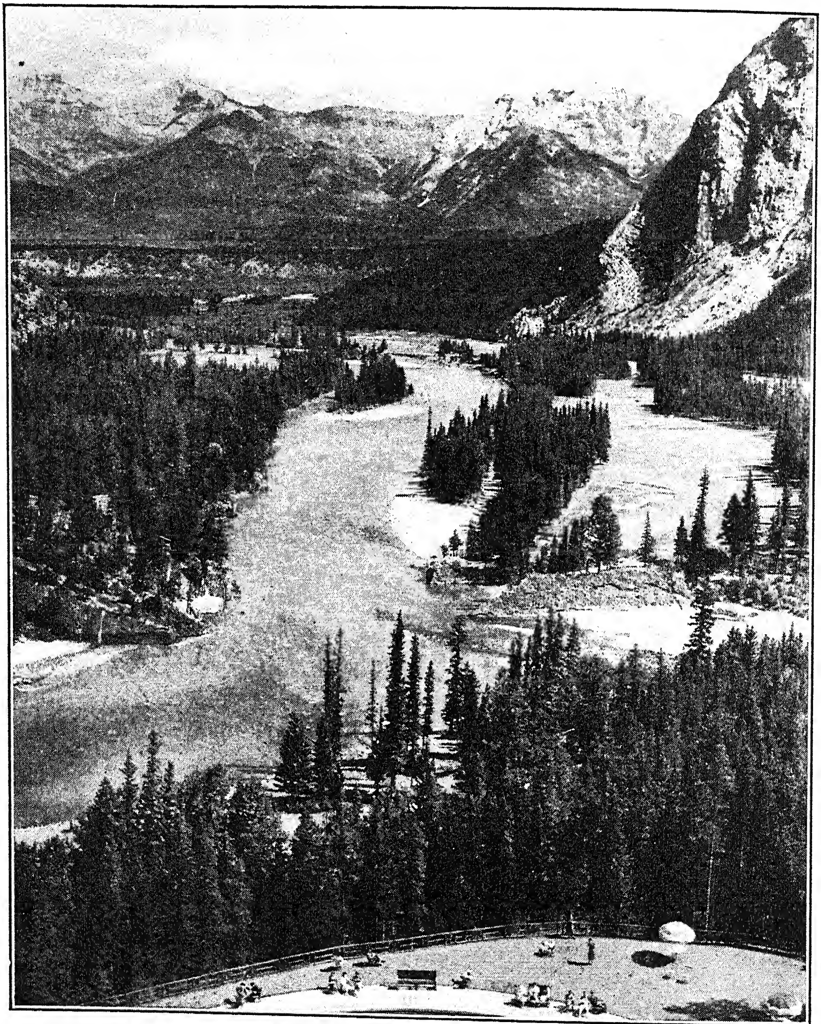

FIG. 92. Valley of the Bow River from Banff Hotel terrace. Golf course on the right. (*Courtesy Canadian Pacific Railway.*)

Wildlife, Fish, and Game

The prevalence of rugged mountains, the wide spread of forest cover, and the lush grasses of meadow and parklands have combined

to favor large wild animal populations Then, too, because more "sportsmen" each year learn to do their shooting with cameras, and lesser numbers kill for sport, wildlife should increase within sane bounds. The Northwest is a natural fish country with cold waters, both salt and fresh, and plentiful spawning grounds in river and lake and ocean shallows This wildlife on land and in the water should continue to increase as a recreational attraction.

The Attraction of Forested Areas

Forests are probably the greatest single recreational assets of the Pacific Northwest. Young forests are as attractive as old ones to many true lovers of nature In the Region today are billions of trees less than 16 inches in diameter Each year they thrive and grow, and in the passing years, if we protect them by effective fire prevention, they will come into their own as towering forest. In national forests, national parks and monuments, in state reservations, in wilderness areas, and in some private preserves, primeval forest areas will be available for study and visits by those interested.

Visitors in Northwest National Forests

Recreational use of national forest areas has shown rapid growth in recent years In 1917, three million people visited national forests throughout the United States, and by 1936 these annual visitors had increased to seventy-one million Five main use classifications are recognized.

1939 CLASSIFICATION OF VISITORS

	Homes	Resorts	Campers	Picnick-ers	Winter Sports	Totals
Washington:	28,547	68,084	228,688	242,598	143,050	710,967
Oregon:	38,687	167,860	373,991	465,604	145,564	1,091,706

The primary purpose of visitors varied from one national forest to another, but fishing, winter sports, and hunting, in order, were among the main activities listed.

Selected Areas for Recreational Concentration

Throughout the great national forest areas of the Pacific Northwest are hundreds of special sites, permanently set apart for:

1. Forest homes—summer home permits for one approved building average $15 a year ground rent, with larger rentals for homes occupied nine or more months a year.

2. Clubs and organizations—larger sites and permit rentals—more than one building allowed upon approval of Forest Service

3. Camp grounds or sites—wholly or partly equipped for camping or picnicking Oregon lists two hundred fifty-five improved forest camps in national forests There are also several hundred unlisted camps for use upon remote and wilderness trips Washington offers one hundred seventy-five camps Idaho and Montana have similar camp facilities

The statistical summary of recreation within the national forests of Montana and Idaho for 1939 is interesting proof of the attractions of these forests and of the cordial welcome and assistance given the visitor:

Summer home. residents and guests	24,408
Hotel and resort guests	84,865
Campers	94,780
Picnickers	419,030
Winter sports participants	62,570
Total	685,653

Mount Hood and Mount Baker, national forest centers of public attention (proclaimed officially as recreation areas), offer roads, automobile camps, and hotels; main highways approaching both forest and park scenic centers are lined with homes hidden in the national forests. Snoqualmie Pass, Washington, is given over to clubs and organizations, and Stevens Pass, Washington, is now being surveyed for similar uses.

The analysis of the influence of Northwest national forests upon recreation would not be complete without the inclusion of those who merely pass through the forests en route. They may miss the fine flavor of forest living, but few escape the forest influence, and millions each year respond to it.

Merely Passing through National Forest, en Route, 1939

Oregon	4,234,310
Washington	1,632,841
Montana and Idaho	2,489,350
1939 Total	8,356,501

Preservation of "Primitive America"

To National Parks has been delegated the duty of safeguarding and developing super-feature areas of the nation. Besides the parks certain choice areas of true wilderness have been designated for restricted recreation. Recognized classes are:

Wilderness Areas. At least 100,000 acres—no motorized transportation—resorts, camps, homes, logging excluded—one-half mile back from any route for motorized transportation

Wild Areas: Same character as the wilderness area, at least 5,000 acres. For the more heavily populated regions of the United States.

Roadless Areas: Where economic values are too great for exclusion—temporary utilization roads alone are allowed.

Virgin Areas: No disturbance of the natural vegetation—less than 5,000 acres.

Natural Areas: "A natural area is one set aside to preserve special botanical or other biological values, but not large enough to qualify as a virgin area."

FIG. 93. Camping in the Snoqualmie National Forest in western Washington. (*U.S. Forest Service.*)

A recently developed project of the Montana Forest Service is typical of these wilderness areas within the national forests. Under the direction of the regional forester three primitive areas have been joined, the Pentagon, the South Fork (Flathead River), and the Sun River, forming a great wilderness along the central Continental Divide. Trails, campsites with horse feed, and a dozen "regions of special interest" are plainly mapped. Resorts and dude ranches hug the boundaries of the area, but do not enter it. Feeder roads radiate from the boundary outward to a distant encirclement of Montana cities and towns, north to Kalispell, Glacier Park, and Shelby; east to Great Falls and west to Polson; south to Helena and Missoula.

Many other primitive areas, including wildlife refuges, are found in the national forests of the Pacific Northwest, from the oceans across the mountains into the Great Plains. Highly selective areas within the

national forests of the Pacific Northwest now given permanency by proclamation are

Mount Baker Recreational Area, Washington
Mount Hood Recreational Area, Oregon
Columbia Gorge Park Area, Oregon
North Cascades Primitive Area, Washington
Glacier Peak Recreational Area, Washington
Pentagon-Sun River-South Fork Primitive Area, Montana
Goat Rocks Wild Area, Washington

Trails in the National Forest

Except in the rain-drenched slopes where few tourists care to penetrate and where maintenance is almost prohibitive, inviting trails wind through both lowland and upland forest. An outstanding example is the Cascade Crest Trail, now nearing completion, which clings to the high rugged divide of the Cascade Ranges from Canada to Oregon, continues through Oregon as the Skyline Trail, and extends through the backbone of California to the Mexican border Within a few years these crest trails of the three Pacific States will be welded into the Pacific Crest Trail System, combining more recreational features and greater distances than any other trail system in the world.

National Parks and Monuments

The Pacific Northwest now possesses six national parks and six national monuments, each established because of distinctive features (see Tables 20 and 21) The distinctive features of the six United States national parks in the Region, together with other interesting scenic attractions, are one of the most important factors in stimulating Northwest tourism [1] The government has provided free nature-guide service by range-naturalists who explain to the visitors the origin of the scenic features and tell about the trees, flowers, birds, and animals of the parks Paved and oiled highways, hotels, cabins, shelters, and public camps have been provided, the better to play host successfully to millions of recreationists Nearly one and a half million visitors yearly enter the various national parks of the Region.

State Parks

The four Northwest states vary greatly in the administration and the scope of their state parks and state recreational areas. State pre-

[1] For descriptions of Yellowstone, Glacier, and Grand Teton National Parks and Craters of the Moon National Monument, see pages 92-96 Crater Lake is mentioned on page 55, Mount Rainier on page 54, and Olympic National Park on page 45

serves in the Pacific Northwest include camping parks, historical parks, recreational parks for swimming, picnicking, and sport competitions, parks for the preservation of scientific features, preservation areas for museum stands of timber, memorial parks. National Park Service is a co-ordinating agency in state development of old parks and of newly presented areas through jurisdiction over Civilian Conservation Corps workers who have done much useful work in building trails, roads, etc.

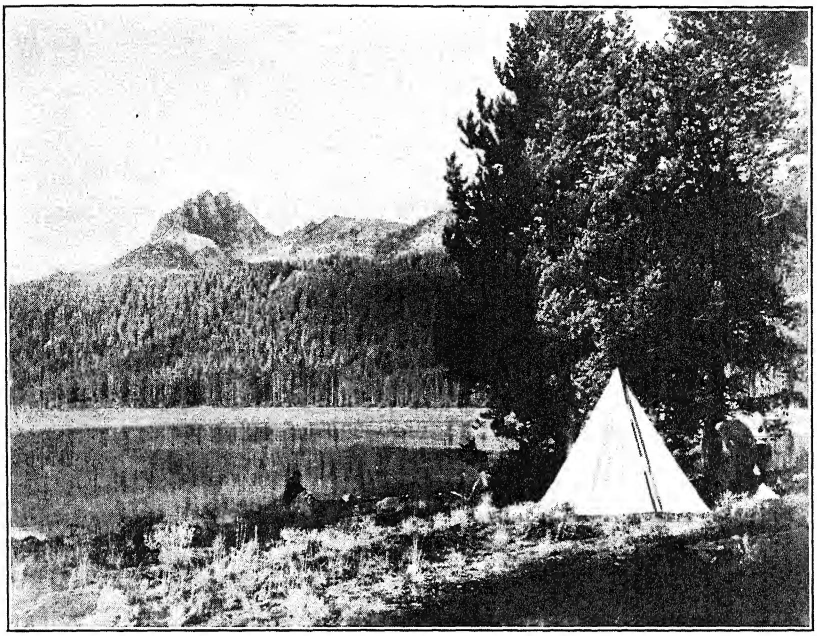

FIG. 94. Camping at picturesque Redfish Lake in the heart of the Sawtooths in Idaho. (*Courtesy Union Pacific Railroad.*)

In Washington the first state park, the Larrabee, eight miles south of Bellingham, has a saltwater beach, a fine stand of timber, automobile camping and recreational equipment. It was a gift in 1915. Other gifts and selections followed. There are now fifty-six state parks with an approximate area of 42,000 acres. Two are outstanding, the Dry Falls State Park of the Grand Coulee and the Ginkgo Petrified Forest near the Vantage Bridge of the Columbia River.

Oregon has given her state highway commission jurisdiction over both state parks and state recreational areas. As a natural result, Oregon has achieved the most advanced public park organization in the United States. This one state had, in 1938, forty-nine state parks

TABLE 20

NATIONAL PARKS OF PACIFIC NORTHWEST

Name	Established	Location	Size	Visitors (1939)	Autos	Features
Yellowstone	1872	Wyo., Mont., Idaho	3,472 sq mi	486,936	140,017	Volcanic, with 3,000 geysers and hot springs, Grand Canyon, lakes, and waterfalls.
Mount Rainier	1899	Washington	378 sq mi.	361,787	90,348	48 sq miles of glaciers on high extinct volcano
Crater Lake	1902	Oregon	251 sq mi	225,101	66,722	Blue lake, 2,000 feet deep, in large crater
Glacier	1910	Northwest Montana	1,538 sq mi.	170,073	46,480	Mountains, glaciers, lakes, etc
Grand Teton	1929	Northwest Wyoming	150 sq mi	87,133	26,390	Sharp-peaked Teton Mountains
Olympic	1938	Northwest Washington	1,305 sq mi	Not available		Snow-capped mountains, virgin forests, giant fir, spruce, and cedar, highest precipitation in the United States

TABLE 21

NATIONAL MONUMENTS OF PACIFIC NORTHWEST

Name	Established	Location	Size	Attendance (1939)	Features
Lewis & Clark Cavern	1908	Southwestern Montana	160 acres		Closed on account of vandalism Will reopen as a Montana State Park
Oregon Cave	1909	Southwestern Oregon	480 "	56,218	Lime formations of great beauty
Shoshone Caverns	1909	Central Wyoming	210 "		Not open at present
Big Hole Battlefield	1910	Southwestern Montana	511 "	3,875	Indian battle, August 9, 1877
Craters of the Moon	1924	Snake River Plain, Idaho	49,602 "	19,270	Recent volcanic flows of weird formation
Whitman Memorial	1940	Walla Walla, Wash	45½ "		Site of Marcus Whitman's mission

and forty state recreational areas, with more to come as need arises and the public becomes convinced of their value

In Idaho the state highway commission is "looking after" her lone state park, with a loose jurisdiction The park is a fine one, the Heyburn, at the south end of Lake Coeur d'Alene, a former Indian tract of 7,838 acres, with summer cottages, camping, picnicking, swimming, boating, and fishing. There are attractive state recreational areas at

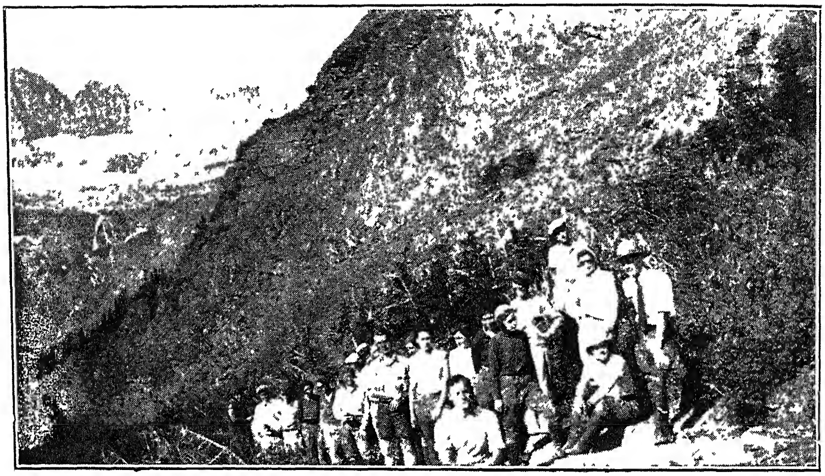

FIG 95 Student hiking party on the trail to Grinnell Glacier in Glacier National Park.

Payette Lake, where winter sports are added to the summer attractions of Heyburn, and at Lava Hot Springs. Morrison Cave, formerly the Lewis and Clark National Monument, is the only state park in Montana. A mountain road is under construction here, and this marvelous cavern will soon be reopened to the general public *guarded from vandalism*!

Canadian Recreation

Thousands of Pacific Northwest recreationists each year visit "Canada's Mountain Playgrounds," for Pacific Northwest tourism is indeed international. For years our mountain clubs have made annual treks to Garibaldi Park (Provincial), to the upper Columbia Ice Field, to Glacier Park (Canadian), to Mount Robson Park, to the Banff National Park districts, to Waterton Lakes National Park, or to lesser developed mountain playgrounds across the border. Or, individual members have joined Canadian clubs on similar ventures.

The Northwest a Retained Frontier

The Northwest is indeed fortunate in its wealth of recreational opportunity, much of it under virtual frontier conditions which have not yet vanished. The wilderness isolation which Daniel Boone knew in the Appalachians of 1775-1800 can still be discovered in much of the Northwest, often within sight of a modern transmontane highway Our unspoiled lakes and waterways, our maelstrom of canyons, peaks, and ranges, as well as our far-flung tangle of forests are a recreational heritage which few residents of the Northwest would care to see dissipated.

In the proper enjoyment of this heritage there is ample room for the Northwesterner himself, as well as for thousands, perhaps millions, of visitors from parts of America where the frontier has become a thing of the past Guests within our gates, sympathetic toward nature and trained in the art of outdoor living, are more than welcome But the Northwest is resolutely determined to safeguard its recreational assets from the careless camper, reckless hunter, and despoiler of natural scenery Properly managed and conserved this frontier playground can be preserved in perpetuity as a source of national health and happiness.

PART IV

AGRICULTURE

CHAPTER 14

FARMING TYPES AND SYSTEMS

By Otis W. Freeman

The choice of the type of farming carried on in any particular section depends upon both natural and human factors. The natural factors include water supply, climate, topography, soil, prevalence of pests, plant or animal diseases, location, distance to market, etc Among the human variables are price, both of land and crops, ownership and tenure of the operator, marketing facilities, distribution and shifting of population, laws, taxes, freight rates, etc. It should be noted that cause and effect relationships between types of farming and the associated factors are not always easily recognized. Generally, the results come from a combination of factors rather than one only, and some of the relationships may be difficult to determine. For example, factors like character of soil, relief, amount of water used for irrigation, and presence or absence of drainage may determine whether certain fields are impregnated with alkali, are so wet that they find use for pasture only, or may be used for various crops. The success factor or factors may be difficult to determine. Or insect pests like the beet leaf hopper may spoil a sugar beet region, as has happened in several parts of the Snake River Valley Certain counties have had similar difficulties with the alfalfa weevil. The control of pests like the codling moth may add so much to the expense of growing apples that it becomes one factor in causing growers to cut down their trees and turn to some other crop Morning glory vines, tar weed, fan weed, and other injurious weeds sometimes become such pests that the economy of a district may be impaired. Increases in taxes and freight rates may force a change in crops grown, the same thing may result from collapse of prices, or competition with growers closer to markets. Laws that compel the washing of spray residue from apples or that penalize eggs and dairy products shipped into distant markets also affect crop systems and compel changes by the farmers in order to secure economic safety.

Gradually, as the result of trial and error, farmers gained the needed

experience and knowledge and learned the best crops and farming systems adapted to the Northwest. Not infrequently the best results were obtained after careful experimentation, and plant and animal breeding, or by the introduction of new species from elsewhere. Co-operative marketing, the agricultural colleges and experiment stations, and regu-

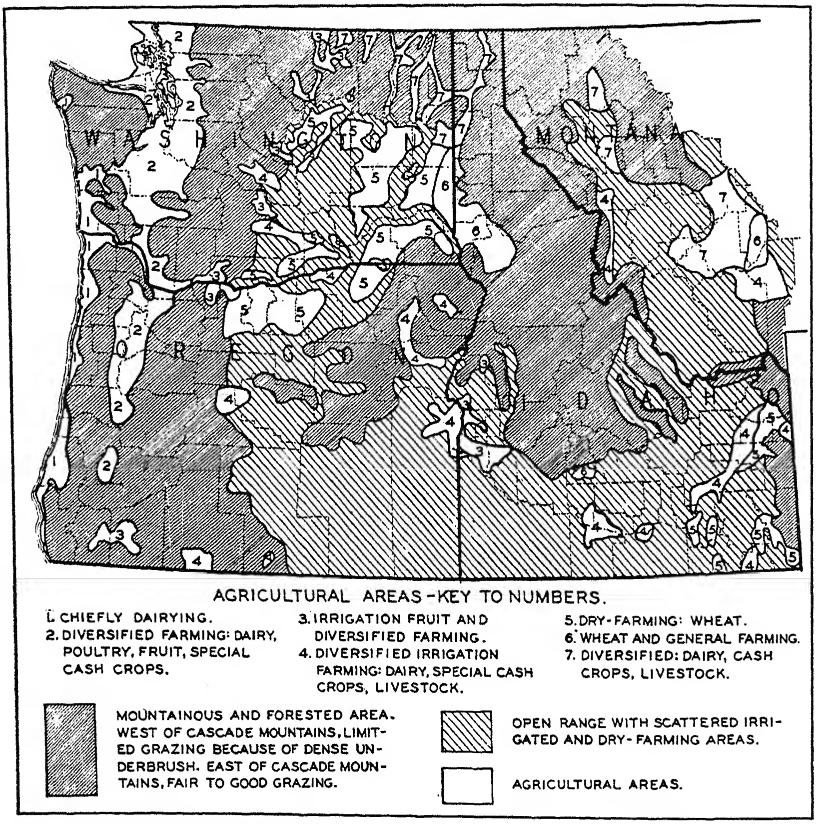

Fig. 96. Pacific Northwest types of farming. (*Pacific Northwest Regional Planning Commission.*)

lations that helped insure quality produce are other factors that had effects on Northwest farm systems.

After discussing briefly the types of farming and farm systems in vogue in the Northwest, we shall describe the leading agricultural products, wheat, fruit, dairying, livestock, etc., in detail in later chapters. The charts showing farm-work schedules, Figs. 97 and 98, drawn by Harold H. Rhodes, will be found highly instructive to study in

connection with the various types of farming. In Chapter 10 there are also specific data on irrigated lands of the Northwest.

General Farming

General, or diversified, farming, as it is also called, is characterized by a combination of several crop and livestock enterprises A survey in Idaho showed that 40 per cent of the income on general farms came from crops and 46 per cent from livestock and livestock products. This diversification is a sounder economy for most farmers than specialization on one product, since crop failure or low prices may bring financial disaster General farms are quite widely distributed in the Northwest states They are common in the Willamette Valley, where a single farm may grow wheat, oats, clover, and keep dairy cows, hogs, and poultry, and may have an acre in small fruits, or a small orchard of filberts or walnuts, and produce a few beef animals for sale each year The general farm produces most of the food consumed by the operators, who also have the advantage of a variety of sources of income, since there is always something that can be sold to meet expenses Many diversified farms have a wood lot to supply needed fuel and fence posts. A dairy enterprise is especially suitable, since it provides a regular cash income, and furnishes an outlet for farm-grown hay and grain, utilizes available pasture, furnishes manures to help maintain soil fertility, and distributes farm labor more evenly throughout the year

Success of general farming depends greatly upon management, the owner making a more substantial income as operator than he could attain by leasing on shares or for cash rent to tenants From 80 to 90 per cent of general farms in the Northwest are operated by owners or part owners.

In Washington general farming is most common in the northeast mountain valleys of Pend Oreille, Stevens, and Ferry counties, where farms average a quarter to a half section in size In the irrigated sections of eastern Washington they are much smaller, twenty to fifty acres on the average In western Washington small farms are the rule. Those farms devoted to general farming are also between twenty and fifty acres nearer the larger consuming centers, but are two or three times this size in more remote locations This type of farming, well adapted to mountain valleys, is a common system used in the Blue Mountains, the valleys of western Montana and northern Idaho, and on part of the irrigated land of the intermountain country. In Idaho general farms are found scattered widely over the state The homestead

laws account for the fact that most of them are 160 or 320 acres in size. On irrigated projects forty- to eighty-acre general farms are prevalent

The actual types of crops raised on diversified farms are markedly affected by the more specialized farms adjoining. In periods of depression the generalized farm is more self-sufficient than more specialized types and its greater number of enterprises permits emphasis on those which appear to offer the greatest opportunity for profit. The operator of a general farm is usually interested in possessing a permanent home with the expectation of a secure and modest living in preference to gambling on high cash returns from some specialty.

Cash-Grain Farms

Cash-grain farms of the Pacific Northwest are devoted almost exclusively to the production of wheat. Over 80 per cent of the acreage planted is in this crop. The wheatland consists of some of the best soil in the Northwest and includes the Palouse Hills and the sloping plateaus in Washington, Oregon, and Idaho, north and northeast of the Blue-Wallowa Mountains, and portions of the Waterville and Horse Heaven Plateaus There is some cash grain raised in the northern Willamette Valley and southeastern Idaho, especially by irrigation in the central and eastern Snake River Plains. Wheat farms also are important in the Clark Fork Valley of western Montana.

Most of the wheatland was taken for homesteads about a half century ago and various changes have occurred since then. There have been consolidation of farms, abandonment of submarginal land, the widespread substitution of power machinery for horses and men, and the recognition of erosion as a factor that requires control. In the fertile, subhumid Palouse the consolidation of farms into large units resulted from the profits made by raising wheat and the inclination of successful farmers to pyramid their holdings using profits to augment their acreage In sections that are drier than the Palouse, wheat yields decline and a farm must contain two to five sections of land in order to provide adequate income to the operator. Here the problem of the farmer is to farm extensively and not intensively, thereby cheapening production by the use of power machinery so that a profit can be made on yields of wheat of eight to twelve bushels per acre.

Cash-grain farms have a comparatively simple organization which makes them readily adaptable to a system of tenant farming. Nearly half of the wheat farms in many sections are operated by tenants Sometimes cash rent is paid but most frequently a third of the crop is

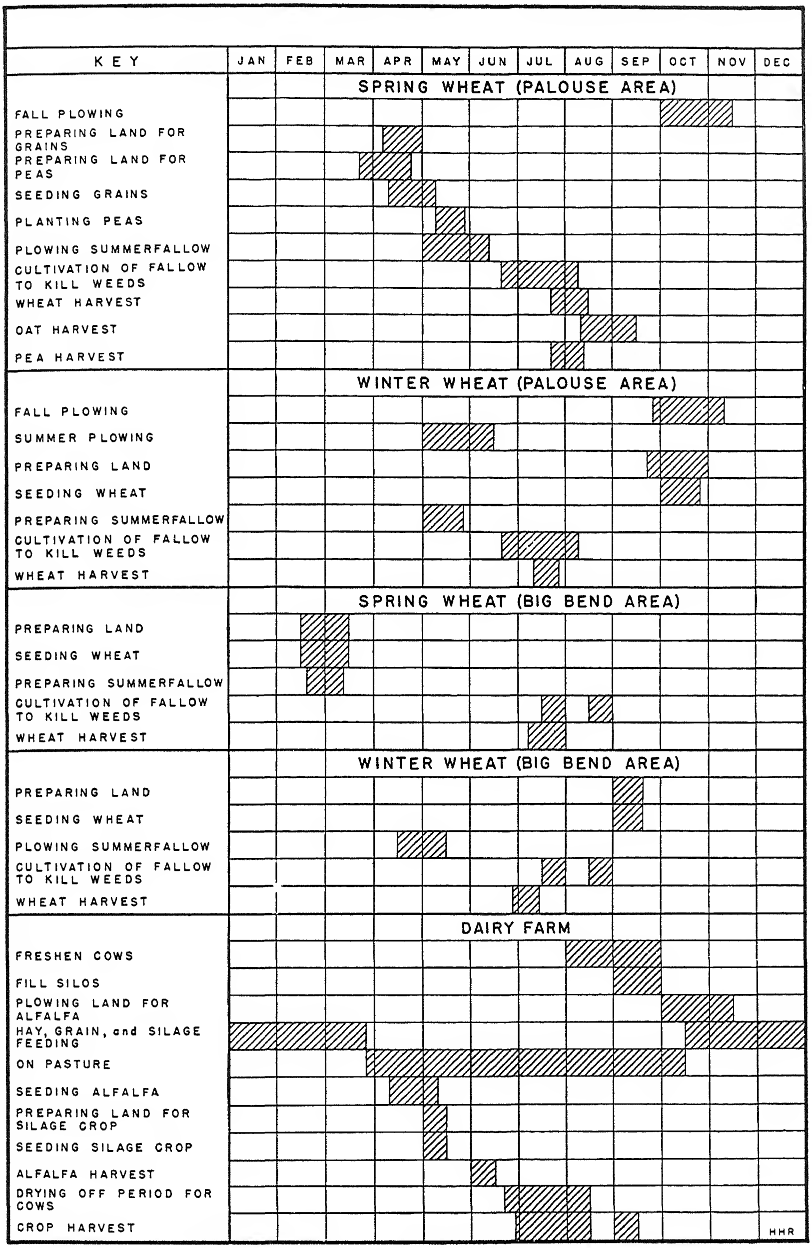

FIG 97 Farm-work schedules Part I

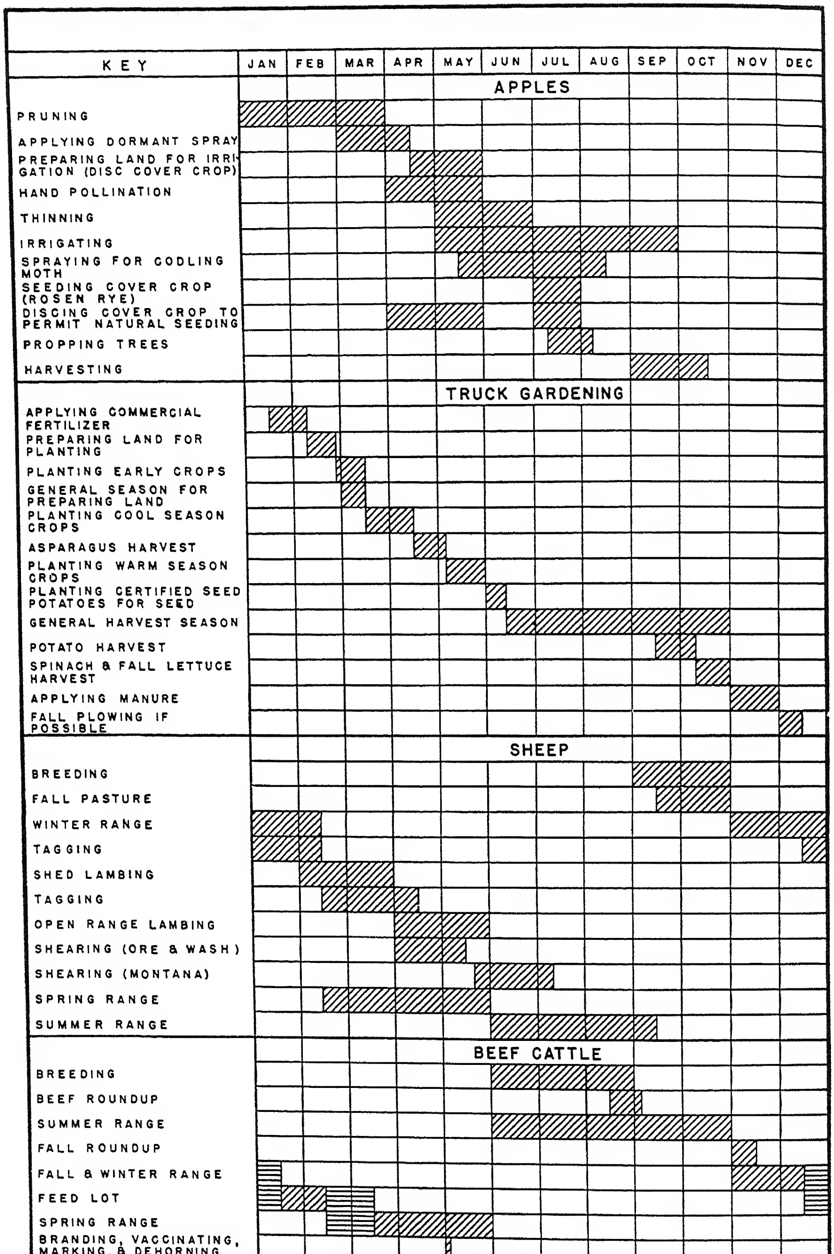

FIG. 98 Farm-work schedules Part II.

delivered to the owner. Experience shows that the share system better divides the risk between owner and tenant.

Livestock is usually a minor adjunct to a wheat farm, many of them having no horses, cows, or even poultry. Some farmers do not even bother with a garden or any crop except wheat. These men must purchase all their food, fuel for their machinery, and everything else they consume, paying for them from their one crop A safer system of farming is to practice diversification, which progressive operators have begun to do

Some successful farmers keep livestock but usually a wheat farmer keeps a cow or two, a pig, and a flock of poultry for his own use only. However, other men have found that a flock of a few score sheep can feed on the weeds in the summer fallow and on the wheat stubble, and pigs and turkeys can be fattened on the grain wasted by the combine in the fields. Even a few beef cattle or milch cows can be maintained on pastures that will utilize eroded land or other parts of farms unsuited to wheat. The fact that livestock can be raised as a by-product at small expense is becoming generally recognized by wheat farmers, and in the future it seems likely that they will practice much more diversification than they do at present When that time comes, it is probable that farms will be reduced in size as the land will then be used more intensively

A cash-grain section such as the Palouse, viewed from the air, presents a curious picture of bare fields of summer fallow, interspersed with green or yellow fields of grain, depending upon the time of year. Contour plowing and rearrangement of fields are beginning, but on the whole the divisions are at right angles, disregarding the hills which dominate the landscape The highways, however, twist through the hills, with long straight stretches a comparative rarity Farmsteads have generally good buildings, especially the houses in the better wheat sections. Barns are a minor feature, except where animal diversification is practiced. Usually there are sheds for the storage of machinery, but sometimes expensive tractors and combines are left exposed to the weather Where rainfall declines, buildings tend to deteriorate; trading towns are also much more widely spaced than in the prosperous regions.

Crop-Specialty Farms

A crop-specialty farm is one from which 40 per cent or more of the value of all farm products is obtained from sugar beets, field peas, beans, hay, potatoes, hops, and other minor field crops In Oregon

specialty farms are numerous in the Willamette Valley, for example, there are 22,000 acres of hops, over half of the American total and equal to 18 per cent of the world's hop acreage The hop yards near Moxee in Yakima County are an example of great concentration The localities specializing on certain crops are mentioned in Chapter 18.

In Idaho and eastern Washington specialty farms most frequently occur in the irrigated sections The average farm of this sort is characterized by the use of almost all the farmland for crop production with relatively small amounts in pasture or waste. Land values are relatively high, and in the irrigated sections crop-specialty farms average from 40 to 160 acres. Three-fourths of these farms in the Yakima Valley are 20 to 100 acres in size. Kittitas crop-specialty farms and those on dryland are somewhat larger. In northern Idaho and the Palouse dry-farming region, larger farms are the rule. Those in the eastern Palouse are mainly devoted to the raising of peas for seed. The large acreage devoted to alfalfa in the Snake River Valley and the Yakima Valley largely results from the demand for hay by the sheep raisers During years of high returns from cash crops, the acreage in alfalfa tends to decrease. Some hay farms are found in the Puget Lowland, especially in Clark, Whatcom, and Skagit counties In Idaho less than a third of the crop-specialty farms keep swine, but those usually have the offspring of two or three sows to market each year as a side line.

To succeed in crop-specialty farming the management should be in the hands of the owner. Where farms are leased they are devoted largely to annual crops that more readily lend themselves to tenant farming Hops, a perennial, are almost invariably produced by owners.

Some specialty crops leave their own cultural features. For example, the alfalfa farms have numerous haystacks or enormous piles of baled hay, the latter protected by rude sheds or covering of boards and canvas A characteristic of a potato district is the huge storage cellars, many of which are owned by co-operative associations. The hop yards have their wire trellises running from post to post to support the vines and homely shedlike kilns in which the hops are dried. During the season hundreds of pickers live in temporary and often nondescript camps, which once seen form a never-to-be-forgotten feature of the area.

Fruit Farms

The fruit farms can be divided conveniently into the orchard fruits and the small fruits. The location of these fruit regions is discussed in

Chapter 16 on orchard fruits and in Chapter 18 on small fruits Fruit farms are generally small In the Wenatchee Valley the apple orchards average fifteen acres About 70 per cent of the fruit farms in the Yakima Valley are ten to fifty acres in size. Of course, not all of a farm is necessarily in fruit. In the Yakima Valley diversification is more common than in the Wenatchee Valley. Berry farms for the most part are small In western Washington they usually are three to twenty acres in size, with many of the farms under three acres. The large amount of intensive hand labor, high value of the producing land, high taxes and water charges, and other expenses all favor small acreages for both tree fruits and berry farms. Orchard management needs both personal interest and experience, and this constant attention and careful handling are best given by an owner, tenants rarely proving satisfactory. However, some large apple properties are successfully handled by managers.

Both orchard and berry farms are small, resulting in a compact population pattern, with trading centers every few miles Most homes in the towns have a family orchard and small fruits Outside the city limits, the fruit orchards are larger and the houses somewhat more scattered, but otherwise there is often little to show where the town leaves off and the country begins Neat houses with all modern improvements, flowers, and yards are characteristic Unfortunately in many orchard districts garages are preferred to poultry houses or cow sheds. In fact, many fruit farms produce nothing but one or several types of fruits and have no cows or chickens and often no garden. In times of low fruit prices or other handicaps, it may prove impossible for a man raising nothing but fruit to meet his expenses, whereas the operator who diversifies and devotes only a part of his acreage to fruit may not make so much money in boom times, but is in a much sounder economic position A fair degree of diversification is practiced in parts of the Yakima Valley and the Willamette Valley, resulting in comparatively less debt and a sounder base for the community than if there were excessive specialization. In Washington several thousand acres of mature bearing apple trees have been pulled out within recent years, on the marginal lands where expenses could not be met during times of low prices. Valuations of fruitland are high compared with that devoted to most other crops, and considerable investment is required to own such a place and much capital is required to finance the crops. Since transportation is vital for the marketing of fruit, the only land that is used for its commercial production is provided with such facilities.

Truck Farming

Although small areas devoted to truck farming are found adjacent to every large city in the Northwest, there are certain districts where truck gardening ranks high among the farm systems In Walla Walla and Franklin counties in Washington truck farms constitute 10 per cent of all farms within the county. In Walla Walla County over three-fourths of the truck farms are three to nineteen acres in size, in Franklin County the majority are twenty to forty acres. Onions rank first as a truck crop in Walla Walla County; melons, lettuce, and asparagus in Franklin County. Other sections important for truck gardens are the Puyallup Valley and the Sumner and Kent districts, the latter famous for its lettuce. The area tributary to Portland contains more truck farms than any other district of Oregon Commercial vegetable production requires large amounts of hand labor, and, although the land yields crops of large value, considerable expense is needed to make it so produce. The work is hard, and oftentimes Oriental and recent immigrant labor is employed. The homes of the hired workers are usually little better than shacks, even the owner may not occupy a first-class dwelling, but the land is always beautifully maintained, a new crop being planted almost before the first is harvested.

Dairying

Dairy farms are widely distributed in the Northwest, and the income from dairying makes this industry the leading one in many sections. Dairying is carried on in a variety of situations Among them are: (1) neighborhood of all cities and towns where demand for fresh milk exists, (2) the green pastures along the Pacific Coast, where soil and climate are ideal for dairying and unsuited for most other farming, (3) irrigated land in the dry interior sections of the Northwest based both on irrigated pastures and alfalfa, (4) mountain valleys and other nonirrigated meadows and pastures unsuited for money crops but available for pasture and hay.

The predominant dairy-producing region of the Northwest is in western Washington and Oregon in a belt of rainfall which has between forty to eighty inches per year. The mountain land may still be in forests but the lowlands have been cleared; the long growing season gives pastures a carrying capacity much greater than nonirrigated ones east of the mountains Summer precipitation is low, but pastures along the river bottom lands receive seepage from upland areas providing sufficient moisture for sustained plant growth. In average production of milk per cow, the Pacific Coast area ranks first among

the dairy regions of the Union Holstein cows are preferred because of their heavy milk production, although herds of Jerseys, Guernseys, Ayrshires, and other breeds are also kept Much milk is sold to the urban population, which totals 1,500,000 people in Washington, Oregon, and British Columbia. In addition, large condenseries and butter and cheese factories utilize the surplus A comparatively small amount of concentrates and hay for winter feeding makes the cost of producing milk comparatively low. Most of the dairy farms in the Puget Sound district have twenty to one hundred acres In Oregon, in addition to a widespread dairy industry in the Willamette Valley, the coastal lowlands valleys, especially at Tillamook, are of great importance. Along the Pacific the dairy industry takes precedence over all other forms of farming put together

Dairying on irrigated land is important in the Yakima, Kittitas, and Walla Walla valleys in Washington, the Deschutes Valley and the Umatilla district in Oregon, in the central and western portions of the Snake River Valley and the Bear Lake district in southeastern Idaho. Usually in irrigated districts, some land receives seepage from adjoining irrigated tracts, making it too wet for crop purposes but available for pasture. In addition, some natural and planted pastures are both irrigated for the dairy cows On some farms devoted to growing alfalfa, the stall feeding of cows is practiced the year around Irrigated dairy farms are comparatively small in size, half of those of Walla Walla County running between 20 and 100 acres; three-fourths of those in Benton County are 10 to 49 acres in size The dairy farm is usually characterized by a large and well-built barn for shelter and storage of fodder, a milk shed, and other buildings, but silos are relatively unimportant if compared with the Middle West farms

The broad mountain valleys of northeastern Washington and northern Idaho, the scablands and hilly tracts near Spokane, the valleys and high benchlands in the Blue Mountain section, and hilly foothill farms in all the states find in dairying a logical source of income. Terrace areas usually have sufficient rainfall for pasturage the majority of the year, with some bottom land or other moderately level fields on which permanent hay or grain hay can be raised. When cream is shipped, the distance to market is not so important as for fresh milk, and shipments made every few days may take care of the product adequately The skim milk is available for pig, poultry, and calf feed, and pork, veal, eggs, chickens, and other fowl are sold to supplement the income from the cream. An occasional baby beef may also be matured. The carrying capacity of these farms depends upon the amount of hay

that can be produced for winter use. Most of the farms do not raise enough grain and have to purchase concentrated feed, but there would be no profit in producing the milk if the hay had to be purchased The smaller farms still practice hand milking Only the larger places commonly have milking machines.

Dairy farms require labor throughout the year with the peak for labor coming during the haying season. A steady income is earned by the dairymen, but the work is monotonous and vacations are difficult to arrange as cows require milking twice daily. The unirrigated dairy farms in the interior are naturally larger than those in irrigated sections or on the more humid west side. The common size for the dairy farms mentioned is 160 to 320 acres. Like dairy farms elsewhere, the barn is generally larger than the house as befits the requirements. Usually several other buildings to house the calves, pigs, and poultry are in evidence. Gardens and small home orchards are common adjuncts. The work is confining but gives a greater degree of security than most other forms of agriculture.

Animal-Specialty Farms

An animal-specialty farm differs from a stock ranch in that the stock are produced primarily by farm feeding on the specialty farm and by grazing methods on the stock ranch. The cattle, sheep, and hogs on animal-specialty farms are generally maintained and fattened on farm-raised feed and farm pastures, although concentrated feed may be purchased by some feeders In Idaho nearly 80 per cent of all animal-specialty farms are irrigated. In Washington most of those in Yakima County are irrigated, but in the Okanogan Highlands such farms are commonly nonirrigated Ferry County has the highest percentage of farms of this type in Washington, the average size being a quarter to a half section. Since the management of such a farm is an important consideration, 85 per cent or more of the animal-specialty farms are operated by owners or part owners Investments in machinery and the employment of machines are relatively small on the animal-specialty farms, but there are naturally numerous buildings for the shelter of livestock. In southern Idaho sheep rank with beef cattle and hogs on animal-specialty farms, but in other parts of the Northwest beef cattle and hogs are the more important animals. Numerous farms in the Willamette Valley and in northeastern Oregon are of the animal-specialty type The keeping of pigs there is quite closely associated with dairying. An animal-specialty farm resembles general farming except in the relative value of the animal products. Milk produced

is 40 per cent or more of the income on the farm, whereas in general farming the income from the crops and animal products including milk is about equally divided Animal-specialty farms may grade into cash-grain and dairy places as well as general farms

A particular type of animal-specialty farm is devoted to raising foxes or other fur producers. Domestic production of furs is a comparatively new enterprise and one adapted to land of no value for agriculture. The food for the animals can be fish, inferior meat, and cereals, and the shelters can be constructed on any sort of land. Fur farms are found scattered over the entire Northwest but are most frequently located near towns and cities in Oregon around Portland, Eugene, Astoria, and Marshfield. Northwestern Montana, northern Idaho, the Spokane region, and the northern Puget Sound are other sections having numerous fur farms. It is a common industry too in British Columbia and Alaska. In the latter territory off-shore islands where the foxes and mink live in semicaptivity are favored situations.

Stock Ranches

Stock ranches in general are of large size, comparatively few having less than 500 acres, with a section as large as 5,000 acres being more common. Some very large ranches exist in the Northwest, and, whereas the acreage is large, their actual number in any one state is comparatively few. The largest stock ranch in Washington is between Sprague and Lamont and includes about 110,000 acres, not all in one continuous block of land but stretching along for a distance of nearly 30 miles. Stock ranches of more than 10,000 acres include only 2 or 3 per cent of the total number in Idaho. Large ranches are fairly common in eastern Oregon especially in the semidesert areas. In Washington they are of significance in Okanogan, Ferry, Grant, and Yakima counties. A favorite location is near to range in the national forest for summer feeding, with available winter feed in the irrigated valleys that have comparatively mild temperatures during the winter. The sheep ranches in the Columbia Plateau, southern Idaho, and southeastern Oregon use the desert browse for spring feed during the lambing season. When the browse and other herbage become dry and brown in the hot summer and would be nearly worthless, herds of the animals are enjoying grazing in the high mountain forest. They return to the lowland pastures and hay fields for the winter.

The value of the stock ranch is very low per acre. The requirements for grazing per animal are high, often between forty and one hundred acres per animal unit (interpreted as one cow or four sheep). Some of

the stock ranches are merely winter feeding grounds and lambing quarters for sheep, with most of the grazing being secured on national forests and other pastures. Most of the cultivated land, a considerable proportion of which is irrigated, is devoted to hay. Remoteness from railroads is unimportant as the livestock can be driven long distances to shipping points The scablands and other rough land in southeastern Washington, and the canyon slopes and dry rolling plateau areas of Oregon, useless for other purposes, are available for stock ranches. In the early days these were frequently built to their present size by the cow hands taking up homesteads adjacent to the home ranch and later selling the land to their employers. In deserts the control of water was a primary objective in the land ownership. Large stock ranches are seldom homogeneous but rather are scattered over a considerable area, with each holding controlling water supply. By this means, control over large areas of the public domain could be exercised.

The organization of grazing districts under the Taylor Grazing Act now enables the government to exercise control over the range industry. Grazing districts cover all southeastern and much of central Oregon, and one exists just south of the Columbia River in the extreme north-central part of the state. There are also grazing districts in the southern half of Idaho and western Montana, where large enough areas of public domain exist to make it worth while. None have yet been organized in Washington.

Low prices and other bad economic conditions have compelled the liquidation of some old-time stock ranches, but still the range industry in Idaho, Oregon, and Montana is more important than is sometimes recognized because most of the activity occurs in the more remote sections and apart from the better-known agricultural regions of the Pacific Northwest. Machinery, aside from that used in making hay, is not much required on a stock ranch More than 80 per cent of the ranches are managed by owners or part owners. The buildings may sprawl over a considerable area and include numerous corrals and low sheds, the home ranch usually having the largest area of hayland the place possesses Trading centers are few and widely scattered. Stock ranches frequently are located 100 miles or more from shipping points and main supply centers.

Poultry Farms

A poultry farm offers a striking contrast to the huge stock ranch inasmuch as most of the farms devoted to this industry cover only a few acres In Washington the more important poultry sections are

those of the Puget Sound Basin, including the island counties A common size for these farms is ten to forty or fifty acres, but in King, Pierce, and Snohomish counties half of the farms are nine acres or less in size Even on the larger places only a few acres would be actually devoted to the chicken business. In general, the main poultry-producing centers of Washington share much the same area as do the dairy farms. Favorable climatic conditions, rather low price for land, co-operative marketing, and the fact that little capital is required to start in the poultry industry have resulted in a phenomenal growth since 1920.

Poultry raisers often come from among persons who have retired or been displaced in commercial or industrial life of the coast cities A very strong co-operative association has greatly assisted in the marketing of the produce, and its substantial branches are prominent among the commercial buildings of cities in the poultry districts The poultry houses and the flocks of active white Leghorn hens are prominent features of the districts. The dwellings are usually modest ones Poultry raisers commonly have a garden and perhaps a fruit orchard and a cow but seldom are able to raise much of the feed for their flocks, which provide all the cash income The outlay for feed is usually the largest expense. Yakima and Spokane valleys in eastern Washington are active in the poultry business but not nearly so important as the western area In Oregon the Willamette Valley is the leader, where many farms, mostly small, are devoted to this industry Commercial egg production ordinarily brings in about 8 per cent of the gross agricultural income of Oregon Poultry farms, including turkeys, are locally important in Idaho, and a minor industry in western Montana. They are also of general occurrence in the vicinity of cities everywhere in the Northwest. It is probably needless to say that most poultry farms are operated by owners

Self-Sufficing Farms

Self-sufficing farms are those on which half or more of the total value of all farm products is used by the operator's family These self-sufficing farms are found in greatest numbers in the timbered or cut-over areas of the Northwest, as the Puget Sound Lowland, and mountain valleys tributary to the north Idaho panhandle and western Montana They also occur on the cut-over land of the coast region of Oregon and in the foothills about the Willamette Valley Where physical conditions permit, it is possible by planting a variety of crops and keeping several kinds of animals to make a farm nearly self-sufficient. High land values, mortgage payments, and taxes which re-

quire substantial cash payments make it difficult for a farmer to live on a self-sufficing farm. Hence, in general, this type of farm is located beyond the immediate neighborhood of cities and is seldom found within the areas of established substantial agriculture The personal factor is also important, and in general the operators of self-sufficient farms, who are also nearly always the owners, are those who are either willing or forced by necessity to live a "simple life." They must be contented with a somewhat lower standard of living than is found in those types of farming that provide a larger cash income. The quarter-section farm is the more common, but many are of smaller size, especially where purchased from logging companies or other corporations

Most of the self-sufficing farms are nonirrigated, and where irrigation is practiced it is generally a local affair with water taken from some mountain stream or spring The value per acre is low The farm may include much rough land and be inaccessible because of distance from towns and poor roads. The buildings are often of home construction and represent only a small investment Livestock is seldom more than enough to supply family needs, two or three horses, a cow or two, a pig, and a small flock of poultry are about all, the number of animals being limited by the comparatively small amount of hay and grain produced and by the disinclination or inability of the owner-operator to go into the business on an extensive scale. Hand methods of clearing are commonly used because funds are lacking for hiring or for purchase of power and machinery The clearing of land and preparation for crops therefore proceed slowly. Those living on self-sufficing farms are frequently men who have saved a limited amount of capital from logging or industrial occupations and, through age, sickness, or unemployment, have decided to seek independence on a small farm. Another type may be called "residual," and consists of those left behind by a shifting industry like logging With a few cows, pigs, chickens, some hayland, a large garden, small family orchard, and a wood lot from which some cord wood may be produced for sale, it is possible to provide a fair standard of living with a very small cash outlay

Part-Time Farms

The part-time farm is one on which the operator spends 150 days or more off the farm in other than farmwork. Part-time farms are of greatest significance near large cities and highly developed industries, where men live who like to live in the country while employed in factories or service occupations in the city Altogether, thousands of families live on part-time farms. Even in Idaho, where urban popula-

tion is small, a survey showed 2,570 part-time farms in the state, representing 6 per cent of the total In western Washington and the Willamette Valley this number is greatly exceeded. The income derived from part-time farms is not adequate to support a family, but that is generally unimportant as the homeowner expects to earn much of his expenses elsewhere Some part-time farms are associated with the logging industry, and then the farm, in size and general organization, resembles the self-sufficient farms in the area But near the cities the part-time farms seldom exceed more than a few acres in size. Oftentimes the buildings have been wholly or partially built by the owner The garden, poultry, a cow, and berry patch supply much of the food for the family and may furnish a surplus for sale This is a fluctuating farm class and may shift to self-sufficient if business is bad.

Summary

From the combined effects of numerous factors, eleven well-defined types or separate systems of farm enterprises have developed in the Pacific Northwest. (1) general, (2) cash-grain, (3) crop-specialty, (4) orchard and small fruits, (5) truck, (6) dairy, (7) animal-specialty, (8) stock ranch, (9) poultry, (10) self-sufficing, and (11) part-time

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CHAPTER 15

WHEAT AND WHEATLAND UTILIZATION

By Harold H. Rhodes

Wheat is a favorite crop of pioneer lands where locative and climatic factors are suitable for its production Climatic conditions are favorable for wheat in many parts of the Pacific Northwest, particularly south and east of the northern and southern bends of the Columbia River, and south and east of the lower Snake River in Washington and Idaho. Other centers are in southern and southeastern Idaho and in the Willamette Valley. These lands, thinly peopled and new both in an actual and a relative sense, are also remote from the large population and market centers of the United States Under prevailing conditions, wheat is the most profitable agricultural cash crop which can be grown

World and domestic demand for wheat is large and relatively steady. Owing largely to the high yields, to the ease of growing the crop, and to the difficulty of growing and marketing profitably any other crop, wheat came early to be the dominant commodity of the semiarid and subhumid Northwest.

Surplus Wheat

With a surplus crop well above present and potential local needs, the Pacific Northwest has long been a great wheat trader, miller, and shipper. Wheat makes up a large percentage of the rail traffic, and wheat and flour are major commodities in Puget Sound and Columbia River outbound traffic Most of the surplus goes to the Orient, to Europe via the Panama Canal, or to California. The Pacific Northwest produces 10 to 15 per cent of the wheat of the United States, but furnishes more than 20 per cent of the total United States wheat and flour exports.

The economy of the Region is therefore sensitive to world conditions in breadstuffs, including bumper crops and depressed markets The blocked or channeled trade of the last few years and the large-scale wars and attendant restrictions have had their effect on the surplus grain grower of the Northwest.

"Flow" of Wheat. Beginning in the 1870's, the Pacific Northwest grain export rose gradually to about 25,000,000 bushels annually for the 1900-1914 period. During the First World War, Northwest exports were hard hit, but much grain moved east by rail for domestic use. From 1920 to 1930, an average of more than 40,000,000 bushels was exported each year, with an all-time high of 63,000,000 bushels in 1927-1928. Since 1930 there has been a drop in the foreign demand, with Northwest exports at times down to less than 20,000,000 bushels a year.

Until shortly before 1890, most of the wheat and flour exports moved via the Columbia River through Portland. With the intensification of wheat growing in eastern Washington and northern Idaho more grain began to reach Puget Sound, shipments increasing from 1900 through the war period. The Columbia River area regained its leading position after the War and has retained it since. Puget Sound exports of flour, however, exceed those of the Columbia River. Indeed, flour shipments from Puget Sound are greater than its grain exports. Since liners carry most of the flour shipped abroad, Seattle with its greater liner traffic has an advantage over Portland in milled cereals. Spokane and Tacoma follow Seattle and Portland as leading milling centers. Flour mills are widely distributed within or adjacent to the wheat fields east of the Cascades. The Dalles, Pendleton, Boise, Walla Walla, Wenatchee, Ritzville, and Cheney are among the many, minor flour mill sites.

Five to ten million bushels of wheat, principally high-protein, hard red spring, move into the Northwest milling centers each year, chiefly for blending in flour manufacture for domestic consumption.

Relationships of Farmland and Cropland to Total Land Area

Land in Farms. Per Cent of Total Land Area.[1] Of the eight areas of the Pacific Northwest that have more than 40 per cent of the total land area in farms, only one is large (Fig. 99). In two sections of that area, 70 to 98 per cent is in farms. The first, or southeastern Washington, section has a very large percentage of the total land area in farms. Whitman County, for example, has 98.4 per cent and Lincoln County 91.3 per cent. North-central Oregon contains the second section of special note. Gilliam County in that section has 88.2 per cent of its total area in farms.

A large amount of land in southern Oregon and southern Idaho is of minor importance except locally. Most of that land lies on the outer

[1] Data relate to counties.

or lower side of the isopleth[2] of 25 per cent. Arid or desert conditions prevail over most of the area; thus no large percentages of farmland to total land are in evidence except where water is available from ground water or impounded surface sources.

In the low percentage areas of the west, north, and east, forests and mountains are primary factors in explanation of the comparatively

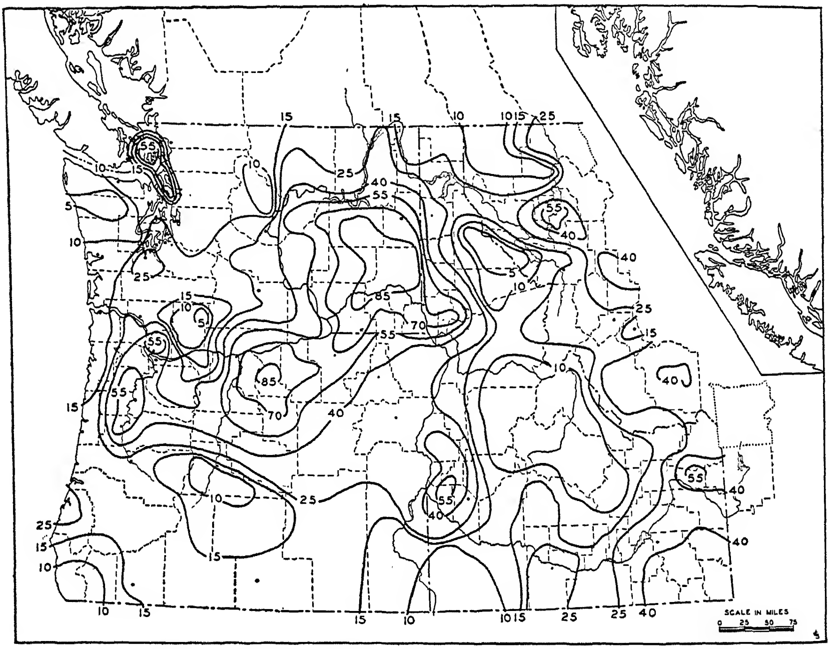

FIG. 99. Land in farms: percentage of total land area.

small importance of farmland in those Pacific Northwest areas. In fact, some of the least well-known parts of the United States lie in rugged central Idaho.

Land in Crops: Per Cent of Total Land Area. The map in Fig. 100 shows total cropped area in relation to total land area. From the map, seven areas appear to be relatively more important than others of the Pacific Northwest with respect to cropped land. Note the close similarity in location of most of the major areas on the maps in Figs. 99 and 100. General correspondence of location can be noted, for instance, between areas within the isopleths of 40 in Fig. 99 and those within the

[2] An isopleth is a line which connects places of equal percentages or equal relationship values.

isopleths of 10 in Fig. 100. Southeastern Washington, south and east of the Columbia River, is shown by both maps to be the outstanding farming and cropland region.

Marked differences in the two maps appear in the percentage relationships. In north-central Oregon, for example, a comparatively small percentage of the total land is cropped in contrast to the large percentage of land in farms. Poorer lands and particularly lower rainfall

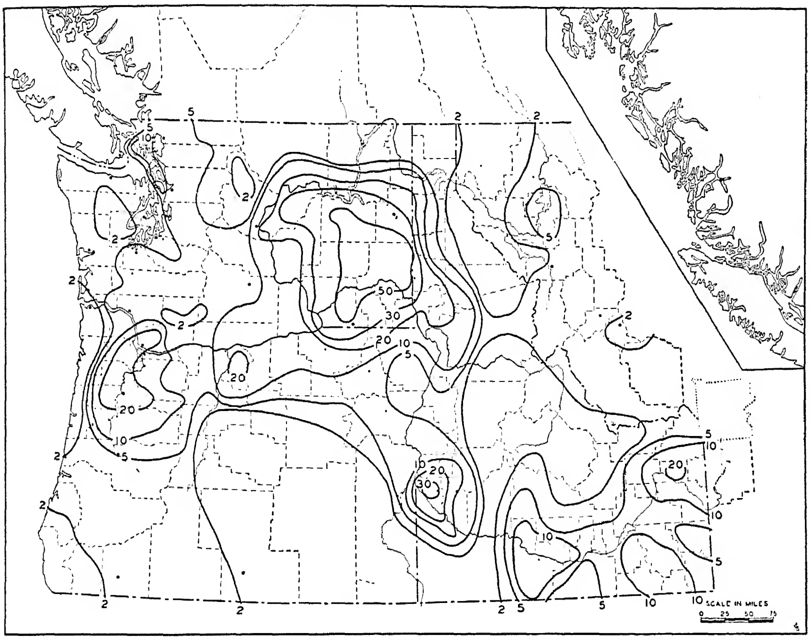

FIG. 100. Land in crops: percentage of total land area.

than in areas farther northeast are major reasons for the unfavorable correlation there as compared with the favorable or high correlation in southeastern Washington and an adjacent part of western Idaho. Other chapters of this book, including those relating to forests, water resources, natural vegetation, climate, and relief features indirectly offer explanation for the small percentage of cropped land in the south-central, west, north, and east-central portions of the Region.

Major Wheat Areas

Land in Wheat: Per Cent of Total Land in Crops. The map, Fig. 101, portrays, on an acreage basis, the relation of wheat to all crops.

Central Area. In each of four large areas of the Pacific Northwest, wheat makes up 20 per cent or more of the total land in crops (Fig. 101). By far the largest of those is the central area, which extends from the Cascade Mountains in an approximate west-east direction to the outliers of the Rocky Mountains. Most of that extensive territory lies along the south side of the Columbia and lower Snake rivers. The northerly bulge, corresponding figuratively to the crown of a hat, lies east and

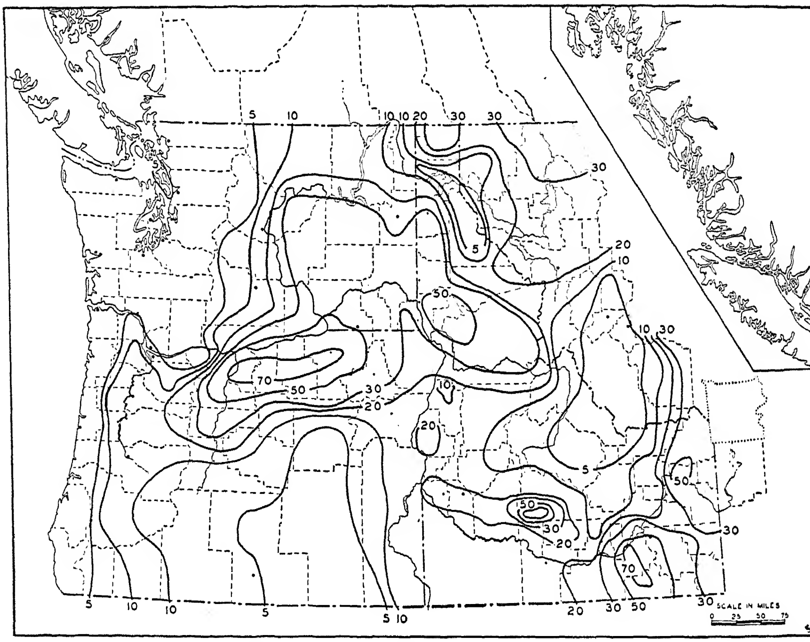

Fig. 101. Land in wheat: percentage of gross cropped area.

north of the lower Snake River. The area in the west and north roughly parallels the bend of the Columbia, but the boundary lies slightly outside the bend. The northern boundary extends east and north of Spokane over into Kootenai County, Idaho. The eastern boundary lies in western Clearwater and Idaho counties.

Although the percentage of land in crops is small in the Oregon section parallel to the Columbia River (Fig. 100), the percentage of wheat in relation to cropped land is large (Fig. 101). Thus wheat production is a major activity in north-central Oregon, where it ranks more favorably with southeastern Washington as a producer than might be anticipated from the map in Fig. 100. In like manner the

oval-shaped section westward in Idaho ranks well with the chief wheatlands of southeastern Washington.

Western Area. In the humid lands west of the Cascades, climatic conditions and competition of other crops relegate wheat to a comparatively minor position in the agricultural economy. However, wheat had the advantage of an early start, being commercially important in the Willamette Valley by 1859. Here wheat now occupies less than 20 per cent of the total land in crops, but its aggregate production for the valley as a whole is large. Stock feeding takes considerable grain in the valley. Partial soil exhaustion, competition in use of land for other products, competition of the large-scale semiarid specialized wheatlands, and new varieties of wheat east of the Cascades have resulted in the gradual decline of the crop in the Willamette Valley.

Northeastern Area. The northern part of the Idaho Panhandle and the Bitterroot-Clark Fork valleys have 20 per cent or more of cropped land in wheat. Total acreage in crops is not large, and wheat, in a relative sense, is a major crop only in spots.

Southeastern Idaho. In southeastern Idaho one area of note appears (Fig 101) within which are two sections separated by Bingham County The northeastern section has 30 to more than 50 per cent of the cropped land devoted to wheat, and the larger southwestern section has 30 to more than 70 per cent. The economy of the latter section is tied principally to the Salt Lake region Barren lava-flow lands of Blaine, Minidoka, and eastern Lincoln counties lie between the two major wheat areas of southern Idaho

Southwestern Snake River Area North of the Snake River from approximately central Lincoln County west to the Idaho-Oregon boundary is a fourth area of the Pacific Northwest in which wheat occupies 20 per cent or more of the cropped land. From the map it appears that wheat is particularly outstanding in the crop combination of the eastern part. In actual acreage, however, the western part is equally important, Canyon and Camas counties each having about 30,000 acres in wheat For general purposes the small district north of Canyon County may be included as an extension of the larger southern area, although it has somewhat poorer wheatland.

Survey of Wheat Agriculture

Acreage. The Pacific Northwest states rank as follows in wheat acreage Washington, 1,934,000, Idaho, 880,000; Oregon, 835,000, and the fourteen western counties of Montana, 113,000.[3] The total is 3,762,000 acres, or about 6 per cent of the United States wheat acreage.

[3] All figures given to nearest thousands

Fallow Land. Fallow-land acreage is larger than the acreage in wheat in the principal Pacific Northwest cash-grain areas. The wheatlands are relatively dry and need an accumulation of one year's moisture for another year's crop. In the Big Bend,[4] for example, much of the land if devoted to crops is suited only to wheat, but the crop must be grown

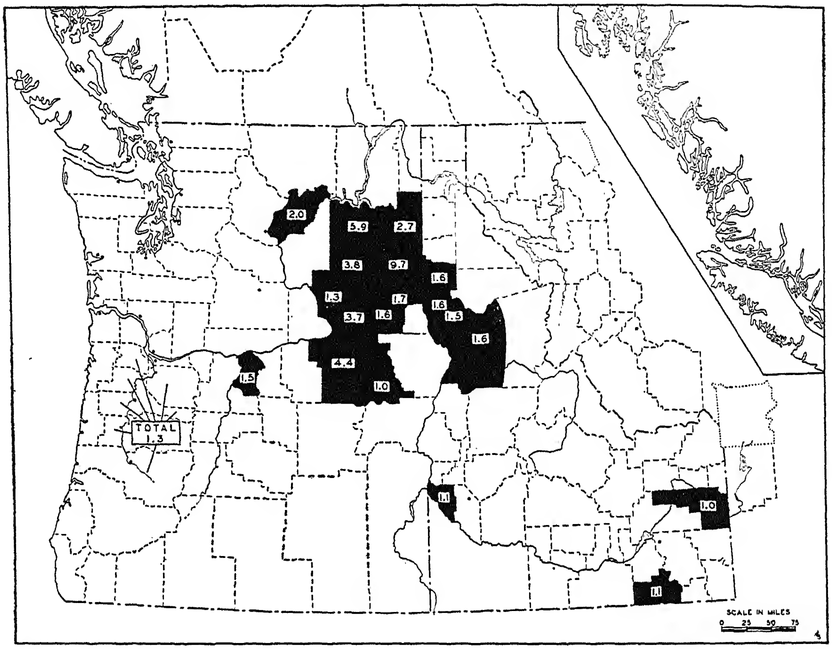

FIG. 102*A*. Nineteen counties, each of which produces more than 1,000,000 bushels of wheat.

by the wheat-fallow method. Acreage of fallow land is small in relation to that of wheat, chiefly in the humid or irrigated areas. The humid Willamette Valley, the irrigated Payette and Boise valleys, and the irrigated Twin Falls area are examples. Irrigated wheat in southern Idaho, as in Canyon County, accounts in large measure for the small relative amount of fallow and the large per acre wheat yield.[5]

Size of Farms. Farms vary greatly in size. The irrigated wheat farms are smallest, those on the dry danger line the largest. In irrigated sec-

[4] The Big Bend is the territory which lies within the large westward "bulge" or bend of the Columbia River. The counties of Douglas, Grant, Franklin, Adams, and Lincoln constitute the Big Bend Area.

[5] Irrigation is a minor factor in wheat production in the Pacific Northwest. Only 5 or 6 per cent of the entire crop is produced with the aid of irrigation.

tions they are about 100 to 175 acres, but near the dry Columbia Basin of Washington and in parts of central Oregon they range from 1,000 to 5,000 acres. In the more humid Palouse most of the farms are 500 to 1,000 acres in extent.

Winter and Spring Wheat. Both winter and spring wheats are grown. Winter grain, with 58 per cent of the acreage and 60 per cent of the

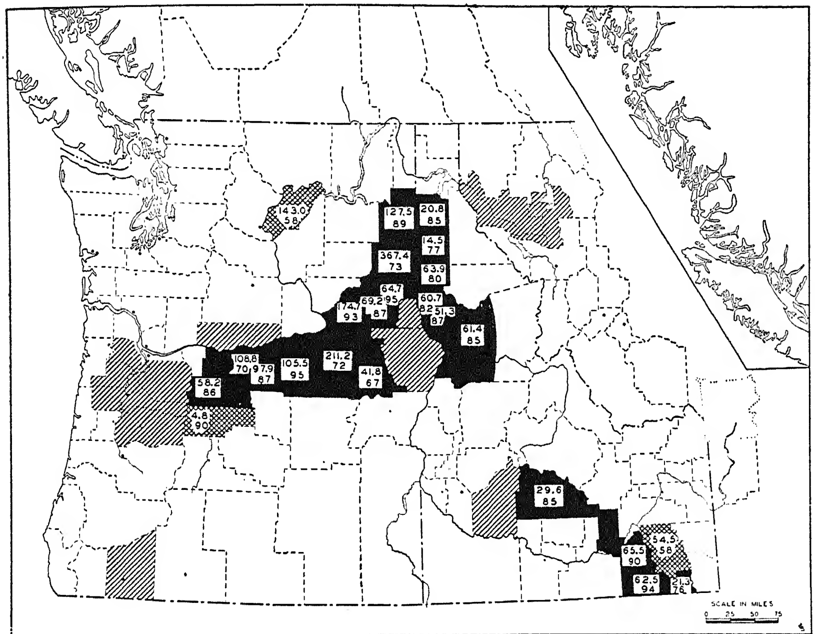

FIG. 102*B*. Counties shaded black have 5,000 acres or more in wheat with 60 per cent or more in winter wheat. Upper figures represent number of acres to nearest thousand and lower figures percentage of winter wheat to total wheat acreage. Cross-hatched counties have less than 60 per cent winter wheat or plant less than 5,000 acres. Counties with diagonal ruling plant have less than 20 per cent of the total acreage in wheat.

production, usually outyields spring. Washington and northern Idaho afford good examples of this higher return from fall-sown crops. Spring wheat in southern Idaho, however, ordinarily outyields winter because of the high returns of irrigated spring grain. In the Northwest as a whole, "Spring varieties are used as a substitute for winter wheat when the fall is dry, as a replacement for winter wheat when it fails to survive the winter, and in certain areas where conditions are generally unfavor-

able for winter wheat."[6] The spring acreage therefore varies greatly from year to year, tending to be high when winter-wheat acreage is low because of light planting or heavy abandonment.[7] Normally abandonment is not large.

Varieties. No one variety of wheat is suited to all soils and rainfall conditions in the Region. By trial and error farmers have learned the varieties best adapted to their lands. Agricultural experiment stations have helped by the breeding of improved strains and new varieties that have largely replaced less desirable wheats. On dryland Turkey is a leading winter variety and Baart is principally used for spring planting. With more rainfall, Triplett and Ridit are satisfactory winter wheats, whereas Bluestem and Federation are preferred for spring seeding.[8]

Harvesting. Harvesting generally begins in mid-July and ends the third week in August (Fig. 97). In the Umatilla section of Oregon cutting occasionally begins the latter part of June. Most of the wheat is now handled by combines of two basic types. Most widely used is the "sack type," which cuts, thrashes, and sacks the grain. The sacks are scattered in groups on the fields and later are collected and hauled by truck to the nearest warehouse or elevator. The other combine is the "bin type" (Fig. 103), which cuts, threshes, and carries the grain unsacked in a bin. A truck meets the combine at designated places on the fields and is automatically loaded with wheat from the combine bin as both combine and truck move along the fields together. One unloading of a combine will not make a full truckload of grain.

Wheat has been shipped in bulk for only a relatively short time, the change to definite dominance of bulk handling for export taking place as recently as 1924-1925. Transportation from farms to terminals in the Northwest is still predominantly in sacks.[9]

Yields. Wheat returns are largest on the irrigated and on the more humid lands. On the irrigated farms yields vary from 30 to 70 bushels per acre. For example, most of the irrigated land in Kittitas and Yakima counties produces more than 30 bushels. The more humid

[6] E. G. Schafer, E. F. Gaines, and O. E. Barbee, "Wheat Production as Influenced by Variety, Time of Seeding and Source of Seed," *State College of Washington Agricultural Experiment Station Bulletin* 159, p. 7, Pullman, March, 1921.

[7] "Wheat Studies of the Food Research Institute," p. 372, Stanford University, Calif., August, 1934.

[8] *State College of Washington Agricultural Experiment Station Bulletin* 289, pp. 40, 43, Pullman, October, 1933.

[9] Wheat sacks in the summer of 1940 were so high priced—twelve to thirteen cents—as a result of war conditions that many farmers used old sacks to move the grain. At warehouses sacks were ripped open, emptied, and taken back to the farms to be used again.

parts of Idaho and Washington return 25 to 50 bushels. On the dry "near desert" lands yields in some sections are less than 5 bushels per acre.

Production. Nineteen counties, or approximately 14 per cent of all Pacific Northwest counties, produce 1,000,000 or more bushels of wheat (Fig. 102*A*). In that category are nine Washington, seven Idaho, and three Oregon counties, with about 48,884,000 bushels or nearly 70 per cent of the total. Whitman County, Washington, is the leader. Indeed,

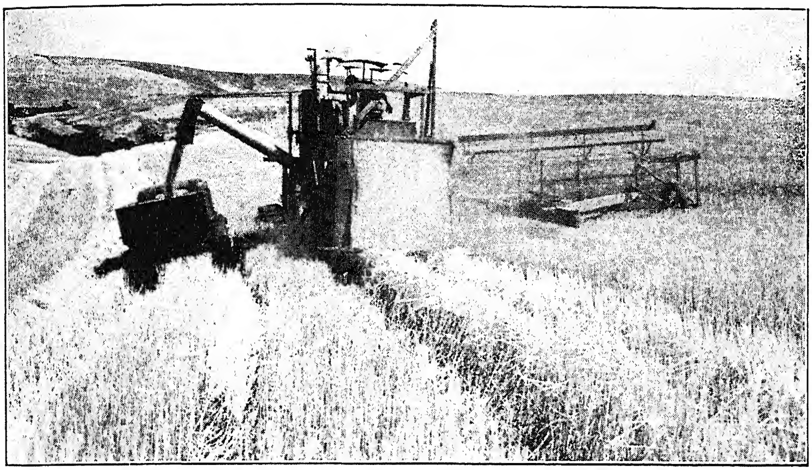

FIG. 103. Combination "sack-and-bin" type combine. Much wheat is trucked in bulk to the railway.

it grows more than one-fourth of the state's wheat, and 13.6 per cent of all that is produced in the Northwest. Of the thirty-nine counties of Washington, the nine shown in black on the map in Fig. 102*A* grow about 87 per cent of Washington's crop and approximately 45 per cent of the total Northwest production.

Because of space limitations the discussion of wheat-growing systems and practices will be limited to the most significant center of the Northwest, the Palouse, and to one contrasting area, the Big Bend.

The Palouse

Part of productive Whitman County and other counties of Washington and Idaho together form the undulating Palouse, with its dune-like appearance from the air. Steeply rolling and maturely dissected, of semihumid climate and loessial soils, the Palouse has long been synonymous with Northwest wheat.

Settlement of these rich prairies began in the early 1870's, although villages near the present sites of Colfax, Washington, and Lewiston,

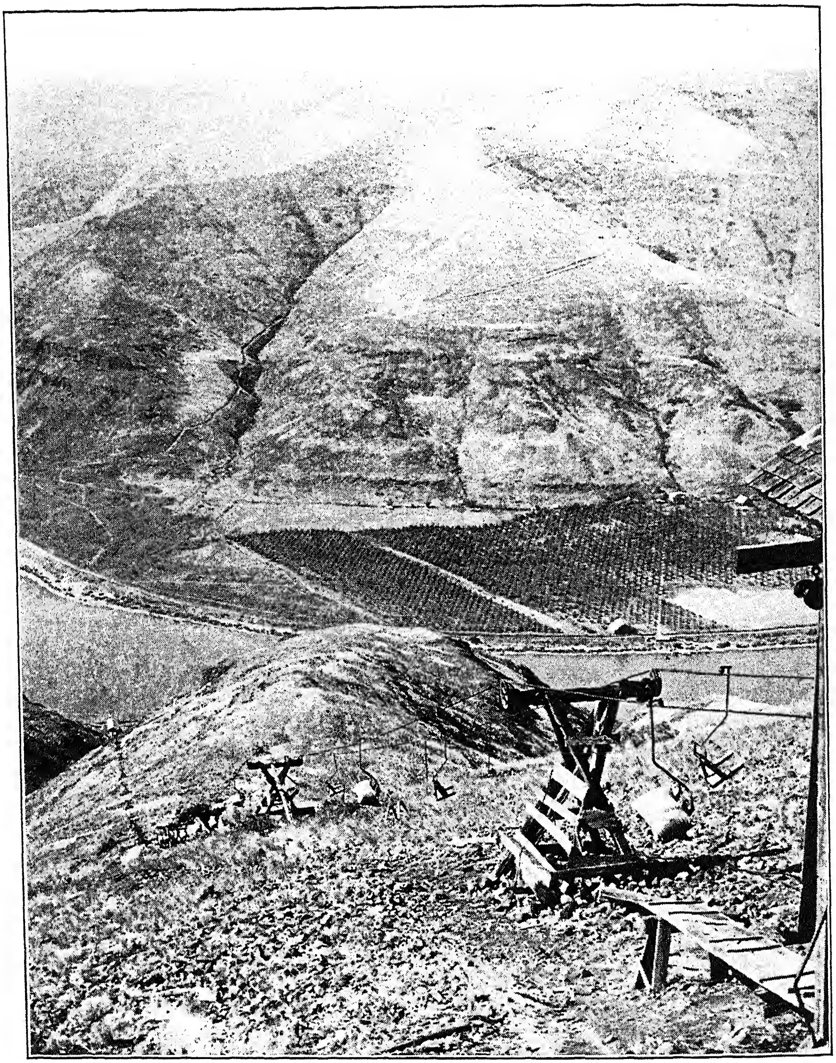

FIG. 104. To save transportation costs, sacked wheat from hill farms above the Snake Canyon is sometimes lowered by aerial conveyor to the railroad.

Idaho, were already established. Cattle had been introduced earlier, but settlers found the land and climate so well suited to wheat that it soon became the dominant crop. Prior to the arrival of railroads in the

early 1880's, the Snake River provided an outlet to the coast for Palouse wheat Gravity tramways were used to move the grain from the upland to river steamers some 1,800 feet below (Fig 104). In addition to improved transportation, the railroads caused a spreading of settlement back from the river and an intensification of land use.

The Farming System Changes Combination grain and livestock farming prevailed up to about 1885 Since virgin land was abundant, only the moderate slopes were opened to cultivation, steep slopes and rough lands were pastured Gradually grain became more and more important and cattle less significant in the agricultural economy The steeper Palouse slopes were plowed. Spring wheat was planted every year. Some oats and barley were later introduced. During the early days considerable grain was cut for hay to be fed to cattle and horses

Soon grain yields declined and a fallow system was introduced. Lack of sufficient moisture some years appears to have been a major reason for the introduction of the system. Prior to 1914 a three-year rotation was practiced, consisting essentially of winter wheat, spring wheat, and fallow Soon thereafter one crop was omitted and a two-year rotation (wheat one year and fallow the next) became common.

Tillage Practices Change Prior to the First World War, tillage practices were simple and the agriculture of the time may be said to have been relatively extensive in character. Horses were used for plowing, harrowing, and harvesting Stubble was cut short and generally not burned Later "the long stubble left by the combine made proper plowing so difficult that the practice of burning it became widespread" Burning was a destructive practice since it resulted in the loss of valuable nitrogen and organic materials and paved the way for diminished crop yields in the future. (See Chapter 7)

During the World War tractors were introduced on many farms, but were inefficient, difficult to handle, and costly to operate. They were successful only on moderately level terrain—a scarcity in the Palouse. With gradual improvement, these machines increased in number, and the decade 1920-1930 saw them widely used Horses, in consequence, became less numerous.[10] This trend toward full mechanization is typical of the wheat areas in the Northwest.

The use of machines led to further changes in utilization of land. Greater intensity and frequency of cultivation were made possible. Finer seed beds could be prepared, less land was needed for forage,

[10] E F Landerholm, "The Economic Relation of Tractors to Farm Organization in the Grain Farming Areas of Eastern Washington," *State College of Washington Agricultural Experiment Station Bulletin* 310, Pullman, April, 1935

and more acreage could be devoted to wheat.[11] Differences in harvest practices as a result of use of mechanical equipment led to burning of wheat and pea residues. This resulted in severe loss of organic materials, which in turn led to breakdown of soil structure and ultimately to diminution in crop yields. By 1933, about 75 to 80 per cent of the grain residues and 90 to 95 per cent of the pea residues were burned. Greater intensity of cultivation made the soil more susceptible to erosion by wind and water. Man and the machine had destroyed the natural balance in another subhumid part of the world.

Present Tillage System.

Wheat is widely grown . . . "usually after summerfallow but also after wheat or field peas . . . the three-year rotation of winter wheat-spring grain-summerfallow is often practiced The land in these rotations is in fallow during the summer months one out of two or three years. Field peas are frequently substituted for summerfallow, usually in a wheat-field pea rotation. Winter wheat is more extensively grown than spring wheat, although both produce satisfactory crops. While the spring grain is usually wheat, it may be either oats or barley

"Summerfallow land that is sown to winter wheat, in either the two- or the three-year rotation, is plowed in the spring, usually during April or May, and is given sufficient summer tillage to control weed growth. The winter wheat is sown on this fallow in the fall during September or October

"Land that is to be sown to spring grain following wheat is commonly prepared by plowing in the fall after the work of sowing winter wheat has been done Plowing may be completed in the early spring if interrupted by unfavorable weather conditions in the fall Early sowing of spring grain is generally recognized as being superior to late sowing."[12]

Destructive Results. Agriculture in the area has been predominantly cash-grain agriculture The land has been maltreated for fifty to sixty years by a cropping system which has taken much from the soil and replaced little. The soil has lost a large amount of its organic material. Its structure has been broken down in part by the pounding and pulverizing of power equipment. On much of the steeper land the "A" horizon or top soil has disappeared. Erosion losses on poorly managed

[11] Four to thirteen million bushels are used for feed purposes in Pacific Northwest wheat areas

[12] E. G Schafer, L C Wheeting, and S C Vandecaveye, "Crop Rotations," *State College of Washington Agricultural Experiment Station Bulletin* 344, p 13, Pullman, March, 1937

lands of the Palouse have been terrific Bald, brownish clay subsoil has appeared Those clay knobs are readily distinguishable even to the untrained eye, and are a sad indicator of man's failure to make a satisfactory adjustment to his environment. Wheat yields are still much higher than the national average, 25 to 50 bushels as compared with 12 to 15 bushels, though yields have declined markedly in many sections of the Palouse.

Readjustments A number of hopeful signs relative to management of wheat farms have been appearing, particularly since 1933 Fallow land has been disappearing,[13] and steep, severely eroded, north slopes subject to snow drifting have been seeded to smooth bromegrass, alfalfa, and orchard grass Clay outcrops on hilltops are now being planted with crested wheatgrass, slender wheatgrass, smooth bromegrass, and alfalfa Sweet clover is now very much in evidence on the farms, whereas, seven or eight years ago, almost no land was devoted to that crop Hay land has approximately doubled in a few years.

Today numerous farms are operated on four-, five-, six-, or seven-year rotation plans. One common plan—a six-year rotation—calls for sweet clover the first and second years, winter grain the third, spring grain the fourth, peas or fallow the fifth, and winter grain the sixth year. A livestock program is being incorporated into the new land-use practices in some sections Livestock seems best suited to certain of the smaller farms. Large-scale wheat farmers are difficult to convert to combination farming They have more leisure time as wheat farmers, have fairly good incomes, and have been content to ignore livestock on any major scale However, some are beginning to keep livestock because of diminishing wheat returns and government subsidies.

Some of the Palouse farmers are now realizing that land-use practices must be altered On one farm, gullies have been brought under control and the upper 25 to 30 per cent of the hills seeded to grasses and taken out of cash-crop production. Those hilltops had been producing less than ten bushels of wheat per acre[14] (Fig 105) Moreover, erosion of the upper slopes threatened the more productive lands below. The lower slopes are being managed more scientifically and the average per acre farm yield has increased Fallow land is greatly reduced, and peas

[13] For example, one farmer's 1,600 acre wheat farm had no land in fallow in 1940. Only a few years ago there was much fallow land even on 40 to 60 per cent slopes.

[14] About ten or more bushels per acre are required in the Palouse in order to return a profit according to the farmers' way of computing values, hence some feel that it does not pay to grow wheat on those submarginal lands Several factors, including wheat prices and the value set on such land, should be considered

are becoming more important in the crop combination.[15] Peas give the operator a cash return and also serve to build up the nitrogen content of the soil. Wheat can then be grown on former pea land with good results. By scientific methods it has been shown that a field peas-wheat rotation is "most productive on the basis of income per acre." There may be less land in wheat in the future, but the cultural

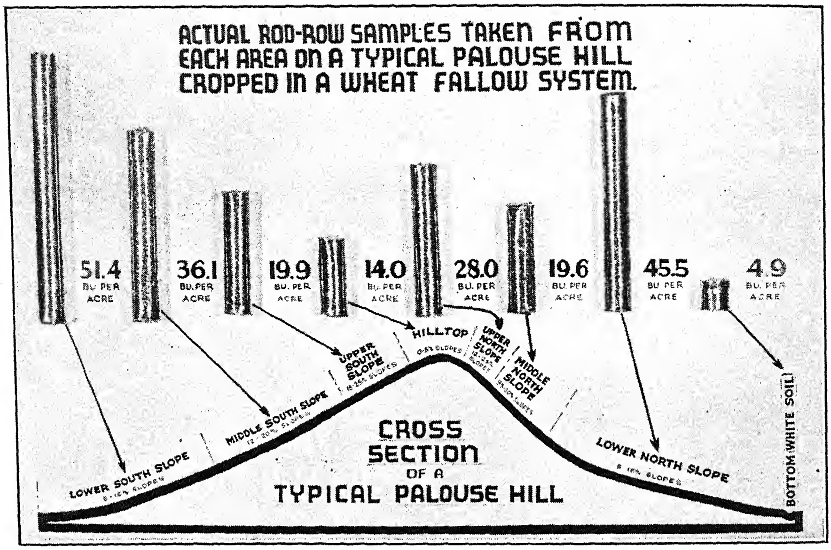

FIG. 105. Cross-section of a typical Palouse Hill, showing comparative yields of wheat. Sample soil columns from the same sections showed the following results:

Section	*Depth of top soil*
Lower south slope	44 inches
Middle south slope	18 inches
Upper south slope	10 inches
Hill top	none
Upper north slope	20 inches
Middle north slope	24 inches
Lower north slope	42 inches

landscape of the Palouse is being unmistakably redesigned for the better.

The Big Bend

Another type of wheat-growing region is the "Big Bend" between the curving course of the Columbia River northwest and west of the

[15] Condensed from Gordon Klemgard, "Practical Erosion Control as Applied to Grain Growing in the Palouse Country," *Northwest Science*, Vol. 13, February, 1939.

Palouse. It has, in contrast, a surface which is level to undulating and a rainfall under 15 inches. The farms of the Big Bend are of greater size, but the percentage of cropped land is smaller than on the more humid areas to the eastward. Wheat growing in the northern parts of the area is generally successful, but on the Central Plains where the rainfall is 8-10 inches or less yields are so low (a survey shows 45 per cent of the fields yielded under 10 bushels to the acre[16]) that the farms are mostly submarginal On areas of Ritzville soil, many farmers have learned to grow wheat profitably by "stubbling in" the grain without sowing They handle large land units cheaply with power machinery, and they use tillage implements such as weeders and disks that prevent blowing of the soil instead of following plans that promote wind erosion They harvest thousands of acres each year Unless special methods are used, winds cause much damage to cropland by deflationary action particularly on the light "blow soils" Wind erosion is readily observed in frequent dust storms Summer fallowing must be done carefully or wind erosion starts Severe soil losses make it imperative that proper farm-management practices be adopted throughout the Big Bend and parts of Oregon having similar conditions. Establishment of a forage-crop cover appears to be one of the best ways of controlling the wind erosion.

Wheat, as a result of growth under dry conditions, has a high protein content and hence commands a higher price on the market than low-protein wheat, which helps to offset the disadvantage of low yields. In the Columbia Basin, crop failures occur frequently as a result of dry years Yet since no other good cash crop is known that can be grown effectively in the Big Bend, the only alternative to wheat is livestock ranching, and larger farm units than now prevail would be necessary in order to make that adjustment effective and profitable

The Big Bend suffered a sharp population decline[17] from 1910 to 1930 as the result of crop failures and land abandonment as well as consolidation into larger units Development of irrigation through use of water from the Columbia River will undoubtedly result in future increase of population and there should be a material change in the character of land use As a dry-farming wheat country much of the western part of the Big Bend will be subject to contraction and expan-

[16] A E Orr, C P Heisig, J C Knott, and C L Vincent, "Trends and Desirable Adjustments in Washington Agriculture," *State College of Washington Agricultural Experiment Station Bulletin* 335, p 13, Pullman, July, 1936

[17] Paul H Landis, "Rural Population Trends in Washington," Rural Sociology Series in Population, No 1, *State College of Washington Agricultural Experiment Station Bulletin* 333, Pullman, July, 1936.

sion with *dry* and *wet* cycles of precipitation and with periods of low or high prices for wheat.

Conclusion

The present trend indicates that the poorer lands will gradually be taken out of wheat production in the Northwest, as marked by the closer relationship of wheat operators, experiment stations, and government agencies Better varieties of grain are adopted as rapidly as possible after they prove successful in the areas for which they are developed. Work of the federal government through the United States Department of Agriculture, Soil Conservation Service, and other agencies is bringing about readjustments on both poor and good lands In the wheatlands, soil-conservation practices should give the farmer, at little or no additional cost to him for equipment, as much net income as he received by former poor practices Poor wheatlands are being seeded to grass and forage, and by scientific management the good lands should become permanently productive Except for contraction of wheat in the drier peripheral parts of the Northwest, relative areal stability seems likely to prevail for some time. Through greater diversification, the future should show better adjustment of man to land in the Region.

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CHAPTER 16

TREE FRUIT AND NUT INDUSTRY

By R M SHAW

Legend places the first orchard in the Pacific Northwest at Fort Vancouver. In 1824, at a dinner in London honoring Sir George Simpson and his men who were about to depart for service in America, a woman dropped apple seeds from the dessert into Simpson's waistcoat pocket and bade him, in jest, to plant them upon his arrival there When dining at Fort Vancouver three years later, he discovered the seeds in the pocket of the same waistcoat and gave them to the gardener of the Hudson's Bay Company who planted them on the grounds of the fort. The story of commercial production, however, begins in the forties when orchards were planted from grafted trees and seeds brought overland from the East by settlers Development followed, reaching a point in the late fifties and sixties where various fruits were provided for local markets and apples for California

Main expansion of the industry did not occur until the decade 1905-1915, after transcontinental railroads were serving the region and fairly large irrigation projects were in operation Men from all callings of life, in all parts of the country, were attracted to the fruit districts by stories of fortunes to be made in apples. Although distant from markets, the industry grew rapidly, and land suitable to fruit trees was planted about as fast as it was brought under irrigation.[1] The fruit was sold in eastern United States in competition with that grown locally, as well as in many foreign countries.

Several factors, both natural and human, favored these early-day developments Natural conditions, especially in the irrigated valleys, were favorable for growth of trees and heavy production of large, shapely, and well-colored fruit. Absence of summer rainfall minimized fungus diseases, irrigated soils were generally high in the elements of

[1] During the five-year period, 1934-1938, nearly a fourth of American peaches, pears, plums and prunes, cherries, and commercial apples was produced in Washington, Oregon, Idaho, and Montana Production for 1939 in these states was 3,910,604 tons (fresh basis) Washington produced 65 per cent of this amount, Oregon 27 per cent, Idaho 7 per cent, and Montana 1 per cent.

fertility except for a deficiency in humus, an abundance of irrigation water existed, maximum sunshine promoted growth, cool nights colored the fruit, and insect problems were not serious Human factors were important also since northwestern growers did several things that were not done in the East (1) Although early orchards contained many kinds and varieties of fruit, growers soon specialized in order to produce sufficient quantities of one type to ship in carload lots to distant markets at favorable rates This also made it easier to advertise and establish a reputation.[2] (2) Realizing that markets were distant and that a large portion of the selling price went for freight rates, growers found that it paid to ship only fine fruit. Hence, orchards were, as a rule, better pruned and more thoroughly sprayed than was common in the East, resulting in not only better fruit but also a higher average yield (3) Careful grading, attractive packing, and certification of quality were the next contributions to sales promotion. Instead of barrels, boxes holding a bushel of fruit were used. Each box contained apples of even size and quality, individually wrapped in paper, and, to give further confidence to the buyer, was stamped with the names of the grower and professional packer as well as the number of apples

Thus, large size and superior appearance of the fruit, careful selection of varieties, and attractive packing made it possible for northwestern growers to sell to eastern markets sufficiently above the price of eastern fruit to cover transportation costs.

In recent years the industry has not been prosperous and many orchards, especially apple, have been removed. This is reflected in the landscapes of many districts, by occasional areas of dead or uprooted trees and stumps and open spaces among the orchards in contrast to former days. A number of factors account for this condition. (1) To meet northwestern competition, eastern growers have improved their practices. Low-grade apples are rapidly disappearing from the orchards and superior varieties are taking their places The barrel has almost disappeared, being replaced by the bushel basket, and recently by boxes for choice fruit The best of the eastern pack now equals that of the Pacific Northwest in appearance and quality, thus reducing the advantage formerly enjoyed by northwestern growers Apples, widely grown in the East, suffer most from this improvement Sweet cherries, pears, apricots, prunes and plums, which cannot be satisfactorily grown there, suffer less as they meet only the competition of other

[2] In 1907, 95 per cent of all fruit trees in Hood Valley were apple, 87 per cent of which were Newtowns and Spitzenbergs (about evenly divided) The district early acquired a reputation for its fruit, boasting that Queen Victoria was a patron of its apples.

western districts. (2) Increased sales of grapefruit, oranges, and pineapple, sold fresh, canned, or as juices by effective advertising methods, have lessened the demand for northwestern deciduous fruits (3) Increased expenditures for insect control and other expenses have resulted in such high costs that, notwithstanding high yield per tree and acre, the cost of producing a bushel of apples is as high, in some cases higher, than in eastern areas. (4) As production costs increased, disadvantage of location was felt, the relatively fixed costs of transportation to eastern markets becoming disproportionately high to the return to the grower. (5) Most of the foreign market has been lost because of trade barriers, warfare, and economic inability to buy.

Any shift from tree fruits to other crops involves such problems as greater suitability of the area for orchards, toxicity of soil due to heavy and prolonged use of lead arsenate in spraying, mental attitude of former orchardists towards other kinds of farming, lack of income for a period of two to six years, investment costs of bringing new crops into production, and revision downward of property values (growers still regard land denuded of orchards of the same value as when raw during the boom period) so that other types of operators who need lower-priced land, such as dairymen, can buy it For these reasons much of the orchard land in some areas remains idle [3]

Location of Orchard Districts

Unlike the wheatlands of the Columbia plateau, the orchard lands of the Northwest are not of impressive extent, but appear as a score or more separate districts scattered about the Region (Fig 106). Most of them are in valleys which provide water for irrigation and sloping lands for air drainage, and are traversed by main or branch lines of railroads leading to Pacific ports and eastern markets The intervening and adjacent areas are lacking in fruit because of ruggedness (mountain areas), cloudiness, and infertile soils (Pacific coast), shortness of growing season (upper Snake valley), or lack of irrigation water (much of the Columbia basin).

Most of the districts are arid or semiarid All have dry summers, even though a few of the westernmost have rather heavy annual rainfall. Consequently, orchardists must irrigate or make some other adjustment (as dry farming) In irrigated districts, permanent cover crops are maintained to enrich the soil In the nonirrigated districts

[3] Of the 5,004 acres of orchards removed from the area of Chelan, Grant, and Douglas counties (Washington), south from Entiat, during the four-year period 1937-1940, probably 80 per cent lies idle The rest of the former apple land has been planted to alfalfa, corn, potatoes, and soft fruits

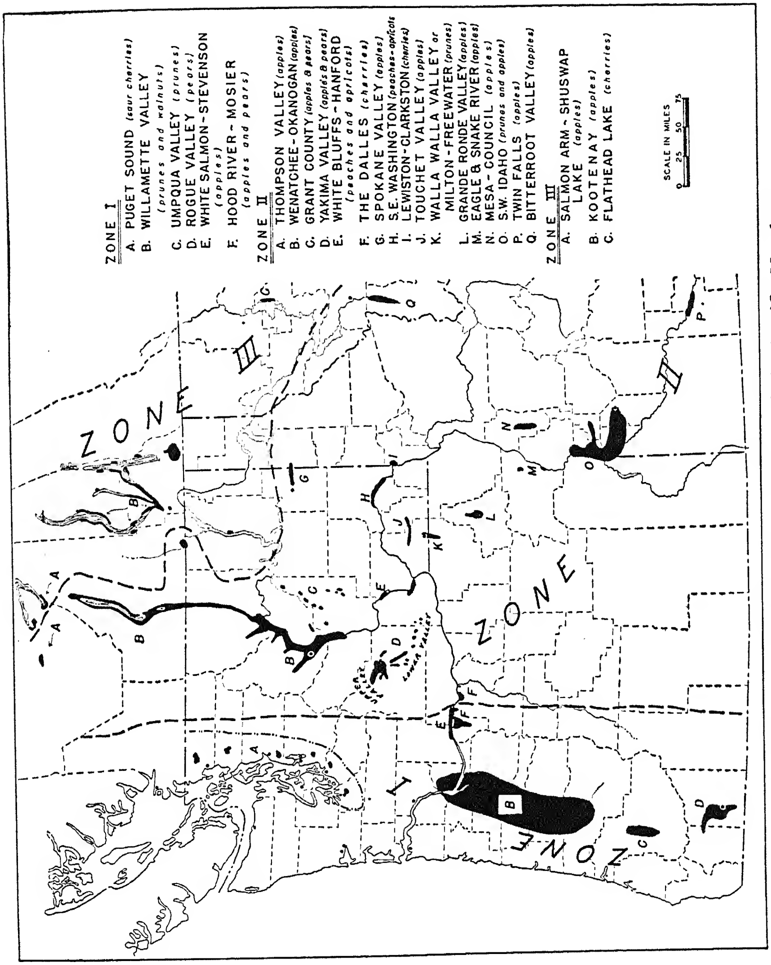

Fig. 106. Tree fruit and nut districts of the Pacific Northwest.

where there is insufficient moisture in summer for both trees and cover crops, orchards are subjected to clean cultivation, although, as in the Willamette Valley, they may be sown to winter crops which are plowed under in the spring.

In Zone I (Fig. 106) the districts were originally wooded and today peripheral orchards often merge with the bordering green forest tracts. Irrigation of fruit trees is scarcely practiced except in the Rogue and

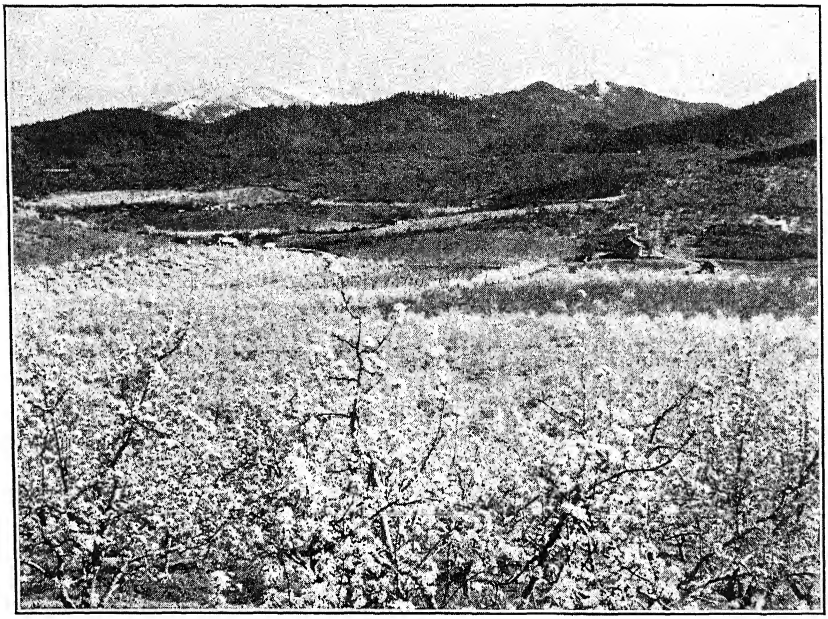

FIG. 107. Pear orchard in the Rogue River Valley, near Medford, Oregon. Cascade Mountains in the background. (*Photograph by Jackson County Chamber of Commerce, Medford, Oregon.*)

Hood valleys, where it was adopted only after commercial orchards had been established for a number of years. Before trees could be planted, the land had to be cleared of its timber. In the Hood River Valley, originally covered with oaks and conifers, Japanese laborers were brought in by landowners to transform the cut-over waste into a vast orchard. In the Umpqua Valley most of the land was open when the orchards were set, having been cultivated to small grains for a number of years.

Zone II, which contains the most districts, is characterized by low mean annual rainfall, original brown landscapes dotted with sagebrush or bunchgrass (more easily cleared than the timber of the first zone),

and irrigation projects The Dalles district is the only one in which orchards are not irrigated. There is some well irrigation along the creeks but most of the orchards are too high up the slope to be reached by water Construction of irrigation projects and planting of hundreds of orchards have greatly transformed the landscapes of districts in this zone Row upon row of trees now grow upon the slopes in orderly succession, in spring a tumbling cascade of sweet-scented blossoms or in fall ruddy and gold with the burden of fruit. In addition to the lovely orchards, some districts are in sight of Mount Adams, Mount Hood, or Mount Rainier, majestic ice-clad volcanic peaks rising above the ridges of the Cascade Mountains (Fig 107). The knifelike division between sagebrush and orchards, frequently following the high line canal, vividly outlines the change wrought by man.

Zone III is similar to Zone I in that it was originally wooded and not all of its orchards are irrigated. On the other hand, separated from it by the dry second zone and occupying an interior position, in general its winter temperatures are lower, its rainfall less (although more than in Zone II), and its fruit areas more elevated

Districts with the largest number of fruit trees are Willamette Valley (5,281,671 trees), Wenatchee-Okanogan (3,882,616 trees), Yakima Valley[4] (3,838,264 trees), Umpqua Valley (908,724 trees), Rogue Valley (870,700 trees), Southwest Idaho (809,634 trees), and Hood River (731,067 trees)

Kinds of Fruit

In 1930, commercial and farm orchards of the Pacific Northwest states (not including British Columbia) contained 24,477,309 fruit trees Of these 40 per cent were apple, 31 per cent plum and prune, 15 per cent pear, 7 per cent cherry, 5 per cent peach, and 2 per cent apricot.

Although each district produces all the deciduous fruits of the region, because of economic, historic, or climatic reasons each is characterized by one or two main fruits (Fig 106).

Apples. The Canadian fruit districts specialize in apples. The Okanagan horticultural district of British Columbia (Okanagan Valley,

[4] In this chapter data for Yakima Valley are actually for Yakima County, in which most of the orchards of the district are located Clark County in southwest Washington is considered a part of the Willamette Valley The Washington-Okanogan district is made up of the Okanagan Valley of British Columbia, the Okanogan and Wenatchee valleys of Washington, and that part of the Columbia Valley that lies betweeen the two latter valleys All tree counts for the districts listed are for 1935 or 1936 except for Southwest Idaho, taken in 1940

Salmon Arm, Shuswap Lake, Thompson Valley) produces 91 per cent of the province's apples, the areas forming the Kootenay horticultural district, 6 per cent. Most important fruit section is the Okanagan Valley In its northern half 86 per cent of all trees are apple, but in its southern half they decline to 53 per cent and soft fruits increase in importance Although the valley is much farther north than Yakima or Wenatchee, the growing of more tender fruits, such as peaches and apricots, is due to the presence of linear lakes The orchards bordering Shuswap Lake and Salmon Arm form the most northerly district of the region, 90 per cent of its 100,000 trees are apple In Thompson Valley[5] there are only 36,436 trees (mainly at Spence's Bridge, Lytton, and Chase), 95 per cent of which are apple Scattered fruit areas, located at favorable sites on river benches and beside long finger lakes in the narrow and deeply embedded valleys of the Rocky Mountains of southeast British Columbia, comprise the Kootenay district, in which 73 per cent of the 337,451 trees are apple Creston Valley, that part of Kootenay Valley between Kootenay Lake and the international boundary, contained 35 per cent of all the fruit trees in 1935 and is the most important part.

Orchards in the Yakima Valley and the section of the Wenatchee-Okanogan district in Washington enable that state to produce 82 per cent of the commercial apples in the American part of the Region. Two-fifths of all trees in the first area are apple, three-fourths, in the second Three smaller districts, Spokane Valley, Touchet Valley, and White Salmon-Stevenson, also specialize in this fruit and add to the state's output. The American division of the Wenatchee-Okanogan district is similar to the Canadian in that apples are all-important in the northern part (90 per cent of all trees in the Okanogan Valley of Washington) but give way somewhat to other fruits in the southern part (61 per cent of the trees in the Columbia Valley from Wagnersburg to the mouth of Moses Coulee are apple). More southerly latitude rather than lakes (as in the Canadian counterpart) accounts for the increased importance of soft fruits. In the Yakima Valley there is a tendency for apples and pears to concentrate in the upper valley (two of whose districts are dissected plateaus) and stone fruits in the lower valley. At one time there were many apple orchards in the latter but the codling moth has

[5] On the high bench at the west end of Kamloops Lake there is an area of deserted orchards The trees were planted by families from England in the years immediately preceding the First World War. On the outbreak of hostilities, every man enlisted and nearly every one died The women made gallant efforts to carry on, but as one by one they received the brief official message of condolence they lost heart and the project was abandoned

become a serious pest there. The warm summer nights favor the flight of this insect. To control it requires about ten cover sprays, which increases the cost of production to a prohibitive point. Moreover, the acid and hot water needed to wash the spray from apples tend to lower their quality and shorten their storage life. Stone fruits are raised without cover sprays and Bartlett pears require fewer than apples. In

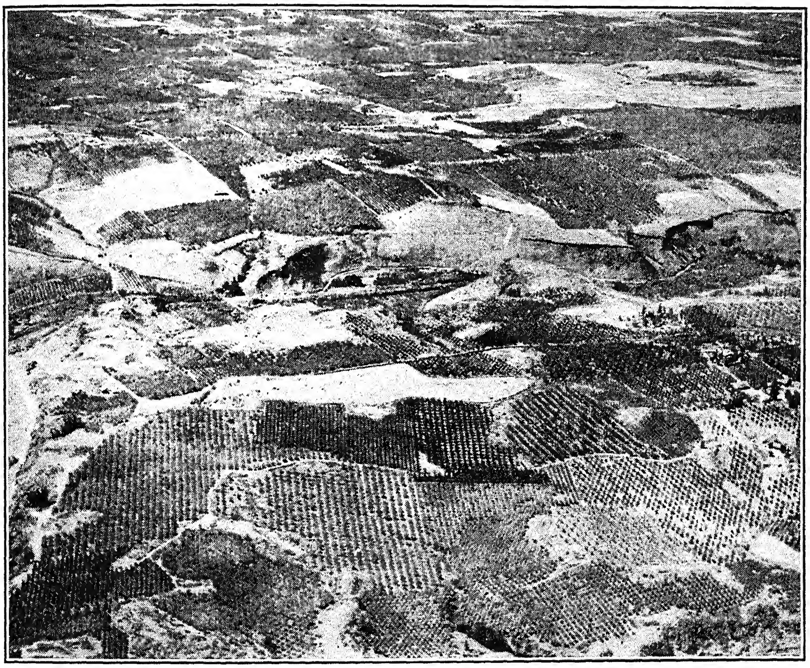

FIG. 108. Naches Heights in the Yakima Valley, where orchards average about 20 acres. Irregularities in outline of orchards are due largely to slope of land and direction in which water flows to best advantage. Bare spots scattered over the picture consist of rock outcroppings, slopes too steep to farm, gravel spots, and spots too high to be irrigated from present ditches.

the upper valley the temperatures are lower, especially at night, and infestation of the codling moth is less. Therefore, three or four sprays are sufficient in most parts, washing the apples is less difficult, a higher-quality product is more easily produced, and the cooler nights result in better color. The lower valley, on the other hand, possesses definite climatic advantages for stone fruits: high temperatures, somewhat less rain and therefore less splitting of cherries, and a growing season one or two weeks earlier, resulting frequently in a price advantage over fruits which reach the markets later.

In Oregon, greatest density of commercial apple trees is in Hood River Valley, which was developed as an export district; at one time 65 per cent or more of its apples were shipped to foreign markets. In recent years the acreage of pears has so increased that pear production may soon equal the apple output. The larger Willamette Valley contains about the same number of apple trees but much of its acreage is not commercial. Production of apples in Idaho is nearly equal to that in Oregon. Two districts, Mesa-Council and Twin Falls, deal

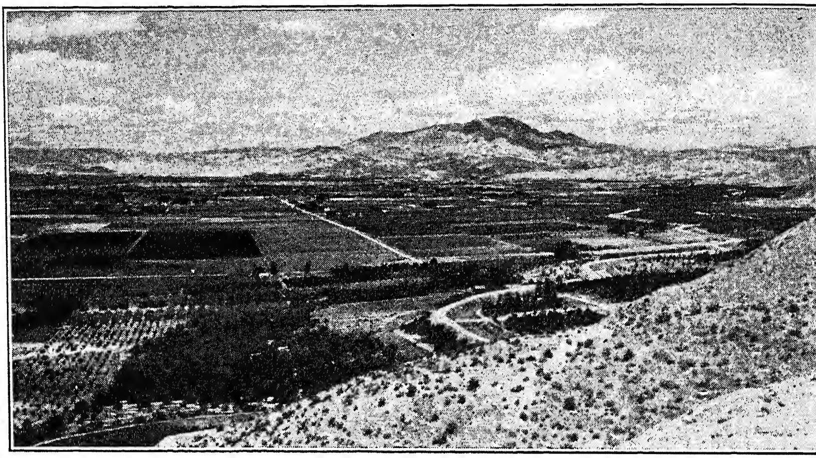

FIG. 109. Emmet Valley, Idaho. Note contrast between irrigated valley and adjoining waste land. (*Photograph by Jackson Studio.*)

chiefly in apples but a third, Southwest Idaho, in which this fruit ranks second, has 1.5 times as many apple trees as both combined. The commercial apples of western Montana are produced largely in the Bitterroot Valley.

In the different parts of the region, emphasis on kinds of apples varies. In northerly British Columbia and in the Bitterroot Valley, most elevated of all districts except the Grande Ronde Valley of Oregon, the variety of first importance is the McIntosh. In the western districts of Oregon (including The Dalles, Mosier, and Hood River Valley with its Washington satellite, White Salmon-Stevenson) there is a preference for Yellow Newtowns and Spitzenbergs. In Washington, Idaho, and eastern Oregon most apple trees are Delicious, Winesap, Rome Beauty, and Jonathan. The Delicious is a favorite variety and ranks high in some parts of those areas favoring the McIntosh, Newtown, and Spitzenberg. In Canada the Delicious comprises a larger

acreage than the McIntosh in the Shuswap Lake-Salmon Arm district and in the Okanagan Valley, south of Penticton. In Hood River Valley it has recently outnumbered Spitzenberg trees and now ranks second to the Newtown. Apple trees less than ten years of age in the American section of the Wenatchee-Okanogan district and the Yakima Valley are predominantly Delicious.

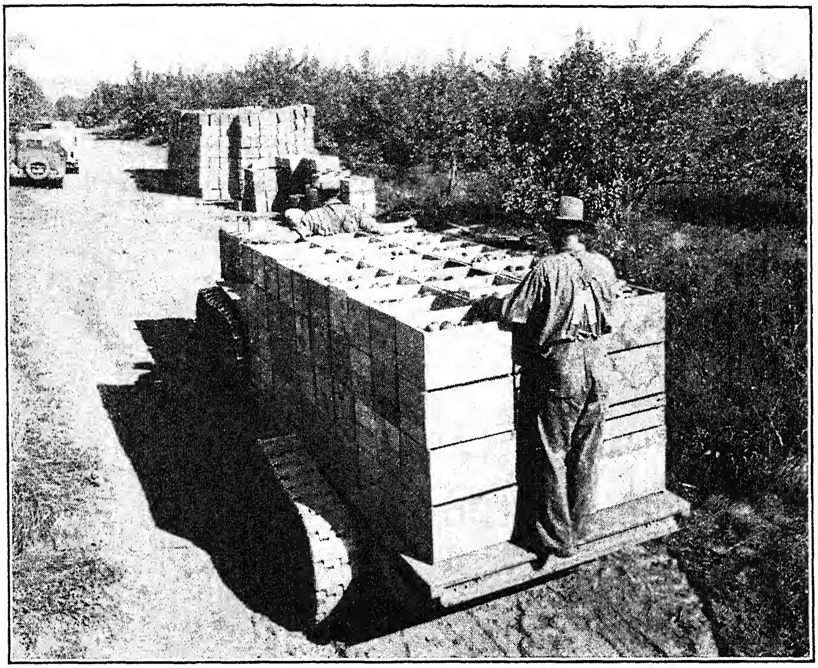

FIG. 110. Apple picking time. (*Photograph by Asahel Curtis.*)

The future of the apple, first commercial fruit in the Northwest and still the leader in number of trees, is at present quite doubtful. In two of the smaller districts, Hanford-White Bluffs and Umatilla, apple trees have practically disappeared. In two of the larger districts, Southwest Idaho and Walla Walla Valley, many apple orchards have been removed and prune orchards are now more numerous. In other large districts, such as the Wenatchee-Okanogan and Yakima Valley, although many apple trees have been uprooted, this fruit is still the favorite.

Prunes. Oregon produces 73 per cent of the prunes in the American section. Three valleys, Umpqua, Willamette, and Walla Walla, contain more prune than all other fruit trees combined. Half of the trees in

the Southwest Idaho district are prune and in the Yakima Valley there are 156,465 prune trees (4 per cent of all trees) The prunes of the two western districts go to driers and canneries, those of the three eastern districts are sold fresh. The western prunes are thinner-skinned and more subject to internal brown rot during shipment than are those grown in the higher and drier eastern districts On the other hand, they are slightly larger and more suitable for canning and drying. The fresh Italian prunes of the inland districts are of high quality, those of the Walla Walla Valley usually bringing the highest prices paid in eastern markets The demand for canned Italian prunes has increased steadily for a number of years, while the market for fresh prunes has held its own. The popularity of the dried prune, however, has shown a marked decline.

Pears. Four areas in Washington and Oregon, the Yakima (14,392 acres in 1936), Rogue (10,903 acres), and Hood River (4,097 acres) valleys and the southern end of the Wenatchee-Okanogan district, including Wenatchee Valley (3,110 acres), produce most of the pears in the American section. Principal varieties are Bartlett, d'Anjou, Bosc, and Winter Nelis More than half of the acreage of the four districts is in Bartletts which predominate in all but Hood River where d'Anjous are more important. The Bartlett is the first to ripen and the only one sold both fresh and canned. The other varieties are known as winter pears and are sold fresh. They keep longer in storage (the d'Anjou until April) and therefore may be marketed over a rather long period

The outstanding district, in which more than half the trees are pear, is the Rogue River Valley (86 per cent of all trees). A combination of climatic and soil conditions has been extremely favorable for the growing of high-quality pears. Moderate winters and summers which are hot and dry are well suited to the ripening of pears.[6] Much of the soil is a rather heavy adobe and is better for pears than for other tree fruits About 35 per cent of the pear trees are Bartlett, 26 per cent d'Anjou, 24 per cent Bosc, 9 per cent Comice, and 4 per cent Winter Nelis A portion of the Bartlett tonnage each year goes to canneries in Willamette Valley and California (only 5 per cent is canned in Rogue River Valley), whereas the remainder is shipped as fresh fruit to eastern markets The Comice pear, which thrives in only a few areas in the United States, is found at its best in the Rogue district. Many are sold

[6] In the Umpqua and Willamette valleys, the other districts of western Oregon, pears are grown commercially but are not included among the most important fruits Summer temperatures are lower than in the Rogue Valley and not warm enough for the best development of most pear varieties

in fancy gift boxes for the Christmas trade and advertised in magazines under the name Royal Riviera

Cherries Four districts, Puget Sound Lowland, The Dalles, Clarkston-Lewiston, and Flathead Lake, specialize in cherries though there are two others, Willamette Valley and Yakima Valley, containing greater acreages Because rains crack sweet cherries, the black Bings and Lamberts and yellow-red Royal Anns are grown in the drier areas Sour cherries are produced in Puget Sound Lowland. More than half the cherries in The Dalles and Willamette Valley districts are Royal Ann. At the time that plantings were made, the chief demand was in the canning field, Royal Anns being the accepted variety for that purpose For that reason cherries of these districts are largely processed. In the remaining sweet-cherry districts the black varieties predominate and a large part of the crop is shipped East as fresh fruit The trees on the east side of Flathead Lake are young, some 60,000 trees (mainly Lambert) just coming into bearing Slow maturation, due to cool nights tempered by the lake, makes for meaty rather than juicy cherries, which adds materially to their keeping and eating qualities In general, sour cherries are canned or frozen, Bings and Lamberts sold fresh, and Royal Anns canned, brined for the maraschino trade, or sold fresh early in the season before the black sweet cherries mature.

Apricots and Peaches. Apricots and peaches bloom earlier than other fruits and are grown where greater security from spring frosts can be expected As already noted, the ameliorating influence of lakes permits the growing of these fruits in the northerly Okanagan Valley of Canada In the only two districts, both small, that specialize in peaches and apricots, Hanford-White Bluffs (Columbia Valley) and Southeast Washington (Snake River Valley), summers are long and hot. Orchards are frequently placed on foothill slopes where drainage of cold air is expedited Four districts stand out in numbers of peach trees Yakima Valley (471,692 trees, or 12 per cent of all fruit trees), Wenatchee-Okanogan (211,845 trees, 5 per cent), Willamette Valley (201,937 trees, 4 per cent), and Southwest Idaho (106,888 trees, 13 per cent) In the American section, 70 per cent of the peaches are produced in Washington, 23 per cent in Oregon, and 7 per cent in Idaho The two districts with the largest numbers of apricot trees are the Wenatchee-Okanogan (205,142) and Yakima Valley (146,238) Most of the trees of the latter are in the Tieton area, a dissected plateau in the upper valley (Fig 108). Although cooler than most other parts of the district, it has excellent air drainage Recent plantings, however, indicate a future shift of apricot production to the recognized soft-fruit areas of

the lower valley. The apricots of The Dalles district are of excellent quality and their production has increased since 1925

Walnuts and Filberts. English walnuts and filberts are grown west of the Cascade Mountains, where both summers and winters are mild, in the Puget Sound Lowland but mostly in Willamette Valley (especially in the northern half), where they rank next to prunes in acreage After harvest, they are artificially dried and the walnuts bleached and graded for size. Most of the nuts are marketed through co-operatives in 50- or 100-pound lots; however, there is a tendency to sell them in small cellophane bags and in recent years a considerable volume has been marketed as shelled nuts They are disposed of largely in the central and eastern states. (See Fig. 11.)

Size of Orchards

The average size of the Region's orchards, located chiefly on valley slopes and benches, is 10 to 40 acres. There are some large ones,[7] among which are the Mesa Orchards (1,200 acres) in the upper Weiser Valley of Idaho and the A. Z. Wells Orchard (265 acres) at Azwell and the Beebe Orchard (500 acres) near Chelan, both in the Columbia Valley. Such orchards are self-sufficient, procuring their own irrigation water, packing, storing, and marketing their own fruit, and maintaining clusters of cabins and houses for the workers (Fig. 111).

Seasonal Activities

Changing seasonal landscapes and activities are typified by the Tieton area. In winter the trees are bare and dormant and pruning is the chief activity. In spring when the trees in bloom flaunt their promise of a coming harvest, orchardists clean ditches and open furrows, spray, disk the cover crop, irrigate, and pollenize with rented hives of bees During summer the growers continue to irrigate and spray, and, in addition, they thin the fruit, prop the bending branches, and harvest cherries (July 1), apricots (July 15), and pears (August 20). The autumn harvest begins September 1 with the picking of Jonathan apples, other varieties are picked in succession, and by November 1 the activity is

[7] During the expansion period an orchard of 8,000 acres (world's largest) was planted on the plateau south of The Dalles district The promoters sold individual investors separate lots on the basis of perpetual care, the owners to reap annual dividends when the trees bore fruit The soil was fertile, but the moisture, though sufficient to produce large crops of wheat by dry-farming methods, was inadequate for fruit and no irrigation water was handy Eventually the owners grubbed thousands of trees and planted the land to grain Similar ventures on a smaller scale were not uncommon, many of the lots being sold to absentee Easterners.

completed. This is the busiest season of the year. Low-wheeled wagons or sleds, pulled by horses or tractors, distribute empty boxes through the orchards and haul filled ones to the road or to the growers' packing houses. Trucks carry empty boxes over the highways to the orchards and filled ones back to commercial packing plants in Yakima. Great numbers of itinerant workers, who live in cheap tourist cabins or on

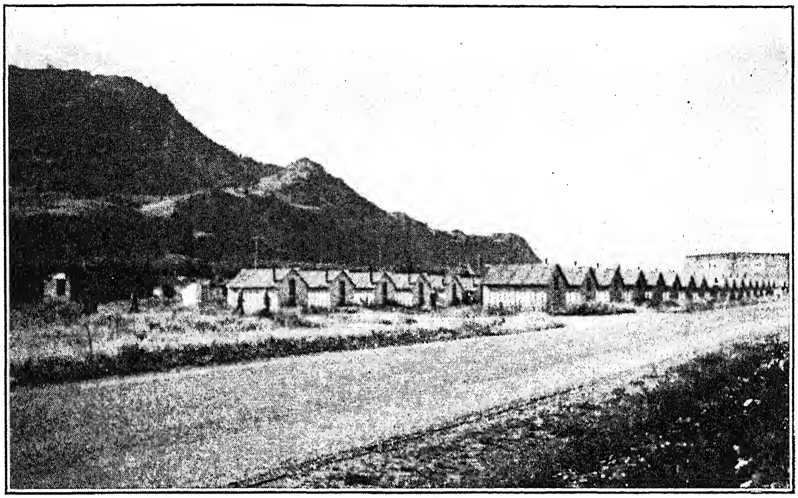

FIG. 111. Cabins for pickers at Azwell, Okanogan Valley. Apple trees on the bench; cold-storage warehouse beside the railway to right of highway.

public camp grounds in trailers and tents, drift in to augment local labor.

Marketing

The fruit may be marketed in various ways, as exemplified by Yakima Valley. Ranking first are large corporative and private organizations through whom growers may dispose of their products to buyers all over the United States and, in the past, Europe. Their frame packing houses and brick-and-tile cold-storage plants are scattered through the valley. Other growers form co-operatives, owning their own packing and storage plants and doing their own marketing. A few pack and sell their fruit themselves. Three large canneries and a vinegar plant at Yakima and a small dehydrator at Buena absorb a portion of the local output. Grocery-store chains and west coast canneries send in buyers for another part. Some fruit is trucked to near-by nonfruit-producing areas, and during the last two seasons a considerable tonnage

has been handled through the Federal Surplus Marketing Administration.

Disposal of the 1939 Crop of the Yakima Valley

	Fresh Fruit (carlots)	Processed (carlots)
Apples	10,629	185
Apricots	85	175
Bartlett pears	800	2,000
Other pears	930	35
Peaches	1,000	400
Plums and prunes	350	...
Sweet cherries	475	100
Sour cherries	...	10

Market Centers

The urban centers which have developed to serve the fruit districts reflect the activity. Orchards come down to their limits and single or

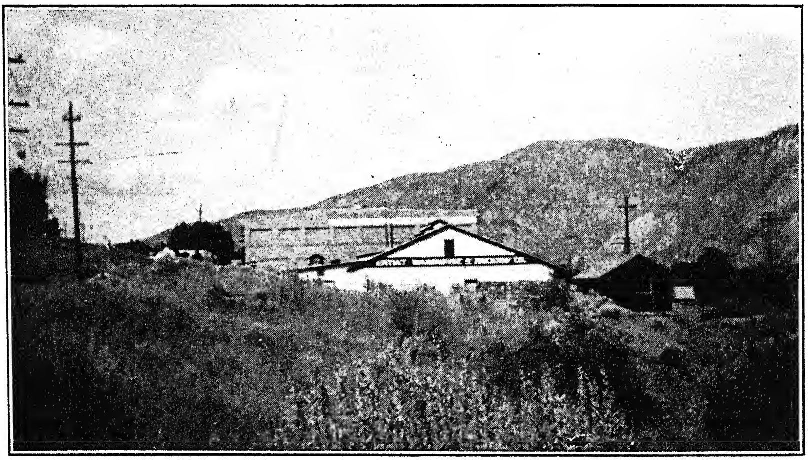

Fig. 112. Apple storage and packing plant at Entiat, Washington.

small groups of trees wedge their way within. Scarce is the yard without a blooming tree in spring. The horticultural character of the surrounding country is seen in the packing and storage houses and processing plants that comprise a part of their landscapes. Small villages, such as Entiat in the Wenatchee-Okanogan district (Fig. 112), are dominated by a packing shed and cold-storage plant. In larger towns like Milton-Freewater, northeastern Oregon, a string of such buildings stretches out along the railroad track for a quarter mile or more. Largest and most pretentious area is "produce row" at Yakima, which with Wenatchee and Medford are the three largest "fruit" cities in the region.

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CHAPTER 17

SMALL FRUITS AND VEGETABLES

By Otis W. Freeman

The Pacific Northwest has certain sections with soil and climate extremely favorable for the commercial production of small fruits. The industry is further benefited by satisfactory transportation, labor, and marketing conditions The culture of small fruits and vegetables is most important in the Puget-Willamette Lowland, where producers find them an important source of income. Economic success for a berry grower depends a great deal on his ability to keep abreast of changing markets and advances in knowledge of fruit culture, control of pests, handling of labor, etc. The human factor equals in importance the natural factors.

Berries

Berries in general require a fertile well-drained soil, an adequate rainfall without excessive moisture in the harvesting season, and relatively early springs so that most of the crop may be sold before the markets have been glutted Requiring less sunshine than commercial orchard fruits, berries flourish in the foggy, cloudy climate on the west side better than east of the Cascades. In general there is no shortage of land suitable for berry production Limiting factors are more commonly the farmer's lack of experience, lack of labor in picking season, and distance from market rather than adverse conditions of soil or climate Most berries, however, do not grow well on wet overflow land or on poor leached soil. The principal areas of production are fertile bottom lands and benchlands, and, west of Portland, rolling uplands.

Labor as a factor in berry production is of prime importance in the picking season An owner may be able to trim and cultivate several acres of strawberries or cane fruit, but berries are such a perishable commodity that they must be picked quickly during the season, so that an acre of small fruit may require the services of many pickers Both local residents and itinerants find employment in the berry-picking season.

The three recognized commercial outlets are (1) the local market for

fresh fruit, which in the larger cities like Seattle, Portland, Vancouver, and Spokane is of considerable magnitude, (2) outside markets in other parts of the United States, including Alaska and Hawaii, (3) local canning, freezing, and preserving plants. Fresh fruit, whether sold locally or shipped, must be consumed within a few days to avoid deterioration The shipping distance for small fruits, being perishable, is limited to markets that can be reached within a few days Glutting of markets may occur from overproduction, too rapid ripening by hot weather, or competition with other producing areas Shipments of small fruits in season are regularly made as far as the Twin Cities and occasionally loganberries have gone to Chicago and further east, but beyond Montana or the western Dakotas competition with other areas generally makes shipments unprofitable. Besides local sales, hundreds of carloads of West Coast small fruits are sent in refrigerator cars to important market centers for distribution east of the Cascade Mountains

Berries are very valuable per acre of producing land Whereas an acre in wheat may produce a crop worth \$10 or \$20, the same area in berries may provide an income of many hundreds of dollars The returns from a berry crop in a single year may even exceed the selling price of the land However, this is not all profit, and in order to produce bumper crops, careful culture and painstaking care are necessary. In addition, large sums are paid to the pickers, and for boxes, transportation, and other expenses that make up the cost of raising and marketing the fruit Not everyone can raise commercial-quality fruit at a profit, but the small-fruit industry does provide large incomes on small areas of cleared land, which is a big advantage where cut-over land covered by huge stumps is very expensive to clear The farms in berry-producing sections are generally small since a few acres are usually all a grower can care for properly. Berry raising is frequently a part-time occupation, especially for people living near large city markets.

Processing Small Fruit

Oregon and Washington are the leading states in the canning of small fruits Exclusive of blueberries, the two states produce three-fifths to three-fourths of the canned berries of the nation. Nearly a million and a half cases of berries come from the Northwest each year· blackberries, loganberries, raspberries, strawberries, and gooseberries in that order. Oregon is first in the packing of loganberries and gooseberries, Washington in the other three Of all loganberries canned in the United States, 98 per cent are processed in Oregon and Washington

The two states also supply a large majority (60-70 per cent) of the national pack of blackberries and gooseberries and nearly half the strawberries and raspberries. Some of the pack is exported, especially loganberries to Great Britain. Canned berries are nonperishable and it is possible to ship them longer distances than the fresh fruit. Favorable locations for canneries are in situations where not only small fruits are available but also vegetables like spinach, peas, beans, tomatoes, or asparagus. Some orchard fruits, especially cherries and prunes, may also be processed in the same plants that handle the berries The overhead of a cannery is about the same whether it operates one month or five months. When several different fruits and vegetables for canning can be secured, operations are naturally much more economical than if there is an attempt to make a profit from the processing of only one or two kinds of crops.

In addition to the berry pack, fruit juice, especially that of loganberries, is bottled. At one time 10 per cent of this fruit was processed in this way, but the output of juice has declined of late years, partly because of lack of advertising Some berry juice is made into liqueurs. Jams and jellies provide another outlet by which the small fruits are marketed at times of the year and to distances which would otherwise be impossible. More preserves, jams, and jellies are made of berries than of all other fruits More than half the total preserves and jams are strawberry.

The use of cold packing for preserving berries began about 1911, and since 1920 the quantity of small fruits preserved by freezing has increased nearly every year. The Pacific Northwest packs more frozen berries than any section of the country. In this form the berries will keep in prime condition for many months A large part of the pack is shipped east in refrigerator cars and sold to bakers, confectioners, restaurants, and ice-cream manufacturers Strawberries make up about two-thirds of the frozen fruit and loganberries much of the remainder. Advantages of the cold pack are that the fruit tastes almost fresh, it can be shipped greater distances than when fresh, the processing is cheaper than canning, and the fruit reaches bakers and other buyers in prime condition Around 100,000 50-gallon barrels (400 pounds net) of frozen berries were sold each year between 1925 and 1930. During the next decade the output of frozen fruit, divided between western Washington and Oregon, increased considerably.

Cane Fruit

The cane fruits include the raspberry, blackberry, loganberry, youngberry, and dewberry; the bush fruits include currants and gooseberries.

The blackberry and dewberry, and even the raspberry in places, grow wild in the Pacific Northwest. The blackberry and raspberry were artificially crossed to produce new fruits, called after their respective discoverers the loganberry, the youngberry, the boysenberry, etc. No part of the world furnishes cane fruits of finer quality than the Pacific Northwest, and numerous varieties grown have been originated there. Probably twice as much acreage is in cane fruits as in strawberries, but the

FIG. 113. Raspberries near Sumner in the Puyallup Valley, western Washington. (*Courtesy Northern Pacific Railway.*)

acreage of no single cane fruit equals the acreage of strawberries. Commercial production of the cane berries is concentrated in the Portland area, in the Willamette Valley, and in the northern half of the Puget Sound Basin. The cane fruits are produced both west and east of Portland south to Salem in important quantities. In 1938 Oregon had over 8,600 acres planted to these small fruits, the income from which to the growers totaled over $1,560,000.

In Washington the Puyallup Valley and other fertile areas adjacent to Seattle, Tacoma, and Olympia are leading producing areas, with important amounts of fruit coming from around Bellingham, the Skagit and Snohomish valleys, and other sections north of Seattle. The small-fruit industry of the Puyallup-Sumner area of Pierce and King

counties is in a section devoted largely to the culture of berry crops, and has the advantage of near-by labor supply from Tacoma and Seattle. The building of canneries was another favorable factor In the specialized berry area of Pierce and King counties the berry farms average five to twenty acres in size, with many of them three acres or less. They are intensively cultivated with but little waste land The ideal climatic and soil conditions, combined with care and skill exercised by growers, result in heavy yields. The land is high in price, but the berry crops return interest on the high valuations. The cane fruits are grown mainly on the bottom lands and strawberries more frequently on the upland soils.

The yield of small fruits varies widely, depending on care given the variety of fruit, the natural conditions, etc. A survey in Oregon indicated that the usual yield in tons per acre was for strawberries 1 70, red raspberries 1 75, blackberries 3.50, blackcaps 1 05, loganberries 1 85, and gooseberries 2.15 The volume of berries per unit of weight varies with the fruit, but can be estimated at around 1,000 quarts per ton of berries. Certain factors, especially the greater availability of moisture in the small-fruit districts of Washington, cause berry yields to exceed usual yields in Oregon by 25 to 50 per cent.

Strawberries

Strawberries are grown under a variety of conditions by small growers who must use land at their disposal, but the fruit is exacting in its soil and climatic requirements, and commercial districts must have favorable factors of soil, drainage, slope of lands, and freedom from frost hazards, and in addition be close to transportation and labor supply Gently sloping land with well-drained, fine sandy loam soil, underlain by a firmer textured subsoil, is best. Such soil is easily tilled and retains moisture and fertility. The soil should be fertile and contain abundant organic matter. Care must be used in setting strawberries, in mulching the patches where severe winters occur, and in keeping the soil in good tilth and free of weeds and pests. Obviously experience and careful attention are required to grow quality strawberries successfully

Strawberries are the leading small fruit. In the United States as a whole strawberries account for one-half the acreage of berries, but the proportion in the Northwest is somewhat less than this Production of strawberries is especially important in the Willamette Valley and in the entire Puget Sound Lowland, including the island counties of Puget Sound. The Hood River Valley, Spokane Valley, Kennewick,

Walla Walla, and Umatilla districts east of the mountains are other areas. The crop in Washington is estimated at 6,500 acres, and in Oregon in 1938 there were 13,400 acres planted to strawberries The farm income from strawberries in Oregon is over $3,500,000 per year Some berries are grown in the Snake River Valley, especially the western portion, in northern Idaho, in the Bitterroot and Flathead valleys of Montana, and in the Fraser River Valley and Vancouver Island of British Columbia About twenty million quarts of strawberries come from Oregon and fifteen million from Washington per year, in addition to those consumed by the producers themselves

Factors and Acreage

Raspberries and blackberries are the most important cane fruits in western Washington, with loganberries leading raspberries and blackberries in Oregon. The gooseberries, youngberries, and currants are next in importance Both the cane and bush fruits require, for optimum growth, fertile soil, humid conditions, and absence of excessively hot, dry weather Since a market and labor for picking are prime essentials, most cane and bush fruits are produced near centers of population on the west side of the Cascades, where plenty of land suitable for the crop is available.

According to the census, the acreage devoted to small fruits in the Northwest approximates the number of farms that report production, which indicates that the average producer has about one acre in strawberries or other small fruits In all, over 14,000 farms in Washington and nearly 20,000 farms in Oregon report small fruits of various sorts with the acreage in Washington approximating 12,000 and in Oregon 22,300 Most of Idaho's production of small fruits is on a small scale Thus, whereas 3,000 farms report strawberries, the entire acreage is less than 700, and with 5,000 farms reporting bush or cane fruits the acreage is little more than 800 acres so that the state is hardly self-supporting in this respect The same situation exists in western Montana As the small fruits are listed separately by the census, there is some duplication involved in the total farms

Miscellaneous Fruits

Increasing quantities of grapes, mostly of the Concord variety, are being marketed from the Yakima Valley for home consumption. At Kennewick, Washington, a factory bottles grapejuice from its own vineyards of several hundred acres and in addition buys grapes from farmer growers. Concord grapes, for juice, are picked when fully ripe,

and the juice is pasteurized and kept at proper temperature to prevent spoilage until bottled, which is done throughout most of the year.

Washington fruit juices are now the basis for a growing wine-making industry, on both sides of the Cascades. The Hood Canal district of Western Washington has a grape-growing, juice-bottling, and wine-making industry centering in Mason County. In eastern Washington, districts such as the Yakima Valley have established wineries using grapes; wines and cordials are also made from apples and berries.

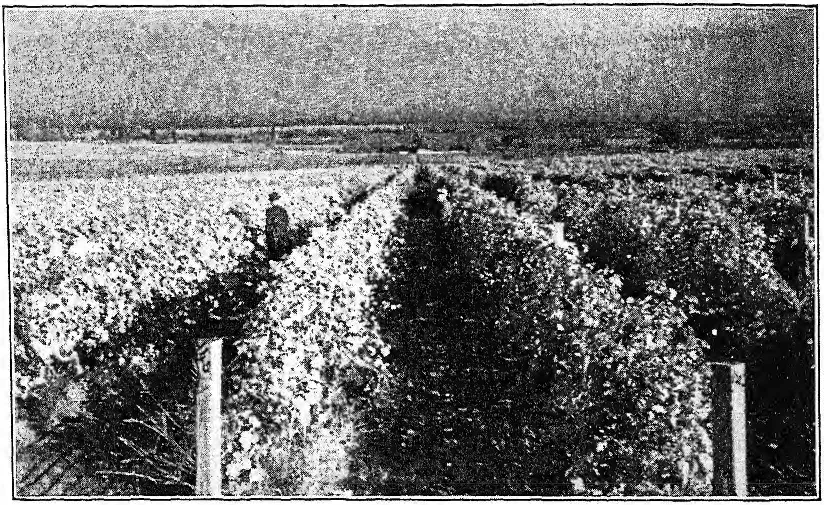

FIG. 114. Grapes near Kennewick, Washington. (*Courtesy Northern Pacific Railway.*)

Cranberry production is important in Pacific County near Willapa Bay and near Grays Harbor in Washington and Coos Bay in Oregon. The cranberries were introduced from the East and have found their natural conditions in peat bogs "fertilized" with acid sand and will thus utilize situations where little else of value can be produced. So far the Northwest does not supply its own consumption of cranberries so that room exists for expansion of this industry. Considerable expense is required to prepare a bog for cranberries. Numerous pickers are needed to gather the crop. In 1940, the Washington output of cranberries totaled 24,000 barrels, and that of Oregon 11,800 barrels.

Several hundred thousand gallons of wild huckleberries are marketed from the mountains of the Northwest each year, and much larger quantities than this are wasted. Experimental canning of the fruit has been tried at Libby, Montana, and other places but no large output like that of the blueberry of the Northeast has yet resulted. There seems little

doubt but that, by artificially propagating and taking care of huckleberries and planting them for canning purposes on cutover land now out of use, a valuable new industry might be developed.

Vegetable Production

All kinds of vegetables flourish in the Northwest, they are produced in home gardens for domestic use, and in market gardens and on truck farms to supply the demand for fresh produce in the urban centers. As for small fruits, the value of vegetables per acre is high in proportion to that of wheat or other field crops For instance, in 1929 about 25,000 acres in Washington alone produced vegetables that sold for nearly $5,000,000, a total of $200 per acre, which approximates the selling value of the land The acreage of vegetables increased from 9,000 in 1919 to 24,000 in 1929 and to nearly 40,000 in 1940. Oregon also tripled its acreage from 6,000 acres in 1919 to 18,000 in 1929. It then produced a crop worth $3,000,000 In 1940 Oregon's output of vegetables and truck was worth about $4,000,000 The Willamette Valley alone plants around 15,000 acres to vegetables annually. Some asparagus, lettuce, tomatoes, etc., are shipped outside the state, especially eastward into Montana, but on the whole the marketing of vegetables is a local business

Some 30,000,000 acres of rich diked land along the lower Columbia River below Portland is peculiarly adapted by soil, climate, and water supply to peas, beans, and other vegetables. Typical yields in tons per acre are string beans 6-8, carrots 12-15, beets 12-14, cabbage 15-30, and unshelled peas 3-6. Green beans, beets, carrots, and peas have been extensively canned in this district. A quick-freeze packing plant is located at Hillsboro Growers also sell quantities of fresh celery, cauliflower, broccoli, and cabbage from the diked lands

Onions are grown extensively in the northern Willamette Valley The Umqua and Rogue River valleys are other important districts for certain vegetables, including tomatoes. The Northwest is comparatively free of insects and fungus diseases affecting truck crops.

In Washington lettuce is the most valuable, especially during the summer, when hot weather elsewhere in the United States precludes the growing of good head lettuce. In the Kent district and other sections of Puget Sound several thousand acres, producing a crop worth around $2,000,000, are devoted to lettuce each year Western Washington lettuce considerably exceeds the consuming capacity of the local area, and thousands of carloads are exported each summer, some to distant markets.

Commercial asparagus is grown in the Yakima Valley, around Kennewick, and Walla Walla. The Walla Walla district is also noted for its spinach. The acreage of tomatoes has increased rapidly during recent years. Melon and squash are found mainly in the irrigated sections east of the mountains, especially along the Columbia and in the Yakima and Walla Walla valleys, with the Roseburg district leading in western Oregon. Cucumbers are raised both for marketing fresh and for pickling.

Many sections of the Northwest raise dry peas which are shipped to eastern markets, where they are either processed for food or are used to supply seed distributors. The larger part of the pea seed comes from southeastern Spokane County and around the Blue Mountains. The Twin Falls region, Idaho, and the Bozeman district of Montana also market dry peas.

Development of Canneries

To an increasing degree vegetables are being grown for sale to canneries. Although canneries are rather widely distributed, the principal producing areas are: in Washington, the Walla Walla, Dayton, Ellensburg, Mt. Vernon, East Stanwood, and Montesano regions; in Montana, the Bozeman area; in Idaho, the Payette district, in Oregon, the Athena and Milton-Freewater districts, and the diked lands from Portland to Astoria.

Peas are by far the most important of all vegetables grown for canning in this Region. The output of peas, both in the northern Puget Sound district and upon the slopes descending from the Blue Mountains of Washington and Oregon near the towns of Dayton, Walla Walla, Athena, and Milton-Freewater, supports a large canning industry Washington is now one of the leading pea-packing states whereas a decade ago the output was inconsiderable.

Along the foothill regions bordering the Blue Mountains in Washington and Oregon, canning peas come from different elevations. Because of varying rates of growth, these areas supply the canneries for a run of several weeks. This district alone supplies one-sixth of all the peas canned in the United States Pea canneries in areas that can raise other vegetables, such as spinach, asparagus, tomatoes, often process these during seasons when peas are not available. This is especially true of Washington canneries.

Such vegetables as green beans, cabbage, asparagus, carrots, beets, spinach, tomatoes as well as some sweet corn are also packed The Payette region produces and cans sweet corn and tomatoes; Dayton

and Walla Walla process almost all vegetables mentioned. A factory to manufacture cans is located at Walla Walla.

By furnishing a definite cash outlet for small fruits and vegetables canneries have helped materially to stabilize the farmer's market. The haul from the farm to the plant usually is short, and the grower delivers his vegetables or fruit when they are prime

Conclusions

On the whole the Puget-Willamette Lowlands are more important in the vegetable and truck industry than areas east of the mountains, probably owing to a combination of proximity to large consuming centers of the Northwest combined with marine-type rainfall, relative coolness, and a long growing season. Another factor is that west side cutover land is expensive to clear, so that it is almost necessary to grow something of high value per acre like vegetables or small fruits on the small acreage cleared, rather than to devote the space to field crops.

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CHAPTER 18

SPECIALTY CROPS

By D. A. Stephenson

The production of crop specialties, together with a varied program of farm activities necessary for their handling, is an important phase of the total agriculture industry of the Pacific Northwest The desire for a cash income is a leading incentive for concentration in certain crops In general the farms devoted to specialty crops are small and are usually located in irrigated sections The growing of specialty crops is not confined to farms usually classified as "crop-specialty farms," but is distributed widely among various classes of farm operators. For instance, in the "cash-grain" farming areas of the Palouse and Camas Prairie regions, many farmers regularly raise peas and beans in their system of crop rotation; also, a large number of them raise potatoes especially when they are high in price Likewise, "general-farm" operators throughout the Northwest raise potatoes, sugar beets, beans, peas, etc, in varying quantities wherever suitable soil and climatic conditions prevail, and where rail facilities or other means of marketing are accessible Thus it is apparent that these special crops must be considered apart from "crop-specialty farm" operations.

Almost without exception specialty crops are raised only when and where especially favorable conditions prevail Among the various factors that affect production are (*a*) dependable water supply which can be regulated as to time and amount, (*b*) soils having the right structural and chemical qualities; (*c*) climatic and weather conditions adapted to the requirements of the particular crop, (*d*) available and adequate transportation, storage, and handling facilities; (*e*) requisite skill and experience in production, (*f*) established and dependable means of financing, and (*g*) available markets. Many of these factors exist to a marked degree in the Willamette Valley, Oregon, in the diked lands of the lower Columbia River, and in the irrigated intermountain valleys of all four states of the Pacific Northwest.

In Idaho, where this type of farming is most common, crop special-

ties are more extensively raised than are other crops. Approximately one-fourth of all farm operations, as well as a fourth of all cropland harvested, is concerned with specialty crops. Furthermore, approximately one-third of the total farm revenues is derived from these sources.

Space does not permit a full discussion of all specialty crops; consequently only some of the more important are discussed, as potatoes, sugar beets, hops, flax, and peas. Although alfalfa hay is not usually considered as a crop specialty, it will be included in this chapter because of its close relationship to the crops treated. In the future more

FIG. 115. An experimental field of soybeans in Spokane Valley. (*Photograph by Leo's Studio.*)

specialty crops may be raised; for example, in 1940 farmers near Richland, Washington, extracted $43,200 worth of peppermint oil from 350 acres in mint. The oil sold for $2 per pound and averaged nearly 62 pounds per acre, giving an income of $124 per acre. Peppermint is also raised for oil in the Willamette Valley. Soybeans are being raised experimentally in the Inland Empire, and along with some other introduced crops offer possibilities for development. In 1940, over 10,000 acres, mostly in the Palouse, were planted to mustard, for use as a spice.

Hay and Forage Crops

Next to wheat, hay and forage exceed all other farm crops in total acreage planted in the Northwest. Many factors combine to

make these crops of great value in the farm economy of this section. Both climatic and soil conditions are generally favorable to high acreage yields, and in the interior the bright sunshine and dry air afford ideal curing conditions. Hay and forage crops, also, form the basis for all classes of livestock industries, which in turn make it possible for farmers to market their produce in the form of butter, cream, wool, and meat. Likewise, the raising of hay and forage enables farmers to practice proper methods of crop rotation, affords the means of controlling weed pests, and helps to reduce soil losses by erosion. On farms situated at high altitudes and those devoted to dairying and livestock, hay is generally the only important crop raised.

Alfalfa is the leading forage crop raised in the Northwest It is extensively grown in all sections which are supplied with irrigation water, it is raised to some extent on non-irrigated lands where the rainfall averages 15 inches or more. The Snake River valley sections of Idaho, the Yakima valley of Washington, and the Gallatin, Yellowstone, and Shields River valley sections of Montana are the chief growing regions

A number of insects and disease pests affect alfalfa and clover stands throughout the Northwest, but these are gradually being brought under control Both acreages devoted to hay crops and those devoted to seed production are being greatly increased.

ALFALFA IN THE NORTHWEST (1934)

State	Tons	Value
Idaho	1,701,638	$14,293,759
Montana	855,550	9 838,825
Oregon	581,607	4,885,499
Washington	526,665	5,055,984

Where it thrives, alfalfa is generally preferred for hay, but where climate, drainage, or soil is unsuitable other fodder crops must be grown In the aggregate a large acreage is devoted to clover in the Willamette Valley, to timothy in many cool mountain valleys, and to grain hay on drylands east of the Cascades. Oats, rye, and wheat are commonly grown for grain hay, where other hay crops fail for various reasons Oats are a favorite fodder crop in the rainy Coastal sections, whereas rye and barley are preferred in the high, dry parts of the Columbia basins and plateaus. Corn is grown to only a small extent. Like alfalfa most of the fodder crops are fed to livestock on the farm. Indeed, the chief crop on most dairy, livestock, sustenance, and general farms is some type of hay.

Potatoes

The potato is one of the most important specialty crops of the Pacific Northwest, and the cash returns therefrom are generally favorable. Since the bulk of the potatoes grown in the Northwest are marketed in the cities and industrial sections, the industry can be seriously affected by the general economic and agricultural conditions throughout the nation. An unusually large crop of potatoes grown in either Maine or Wisconsin may greatly lessen the demand in eastern and middle-western markets for potatoes from the far West Furthermore, potatoes are bulky, and the cost of hauling and marketing may be so near the market price that growers cannot realize a profit, even though they are able to produce bountiful crops. For these reasons the amount of potatoes grown from year to year varies greatly.

Potatoes can be grown in all types of soils and under a wide variety of climatic conditions They grow best, however, in loose, friable, sandy or loamy soils, and in soils which contain a high percentage of phosphorus and potash, likewise, they are climatically suited to regions that have cool nights and warm clear days

Whereas soil and climate are favorable in all four Northwest states, commercial production is confined mainly to areas where transportation and handling facilities are best, and where a dependable supply of irrigation water is obtainable. Thus southern Idaho, the Yakima Valley, Washington, Klamath Falls, Oregon, and the irrigated valley regions of Montana produce the bulk of potatoes grown in the Region. In Idaho potatoes rank next to wheat as a cash crop The Idaho Falls district from Rexburg, on the north, to Pocatello and Blackfoot, on the south, is the largest producing region of Idaho. Next in importance is the Twin Falls district, including the irrigated sections around Burley, Rupert, Gooding, Buhl, and Bliss The Boise-Payette district constitutes a third producing area that grows both summer and fall varieties It includes irrigated land around Nampa, Meridian, New Plymouth, Emmett, and Payette in Idaho, and Vale and Nyssa, Oregon The Yakima Valley is the principal producing district in Washington, although many potatoes are grown in the Palouse and Walla Walla districts In Oregon the Deschutes and Klamath Falls districts east of the Cascades and the Willamette Valley west of the Mountains are important. The Bitterroot, Gallatin, and Yellowstone valleys of Montana grow many potatoes for market.

Fall varieties of potatoes are more commonly grown in the Northwest than early summer types. This is due to the fact that California and other southern rivals can get their summer's crops on the market

ahead of Idaho or the Yakima Valley Freight and handling costs are high, and, to succeed in this business, Northwest growers now specialize in a few superior varieties, grade and label carefully, have co-operative marketing associations, and plant only carefully selected seed potatoes. Idaho grows more than half of the Region's crop of potatoes, totaling around 40,000,000 to 45,000,000 bushels per year.

To maintain high soil fertility as well as to prevent the soil from becoming infested with insects and fungus, growers practice several different systems of crop rotation. The most common rotation is alfalfa or clover two or more years immediately preceding the planting of potatoes. Better results are obtained from this system than from planting potatoes on land following grain Good results are also obtained by planting potatoes on land from which a crop of beans or peas has been harvested.

The potato is subject to a number of diseases, such as scabs, blackleg, dry rot, wilt, jelly end-rot, mosaic, and leaf roll The soil may also become infected with insects, such as potato beetles, flea beetles, wire worms, and cut worms. Five general methods of potato disease and insect control are practiced, (*a*) seed selection, (*b*) seed treatment, (*c*) crop rotation, (*d*) spraying, and (*e*) good storage. No one of these alone is adequate to prevent losses, yet all of them together are fairly effective.

Potato growers generally use machinery for planting, digging, and grading the crop, but considerable physical labor is required in preparing the seed for planting, and in handling the crop both during and after harvest. After being carefully graded, sacked, and labeled, potatoes from the various growing sections are shipped to the Midwest, South, Northeast, and other parts of the United States Some cities halfway across the continent receive more car loadings of potatoes from Idaho than from any other late-crop state.

Much of the crop cannot be immediately marketed after digging, and is stored either on the farm or in facilities provided near shipping terminals Most of the storage in arid sections is in earth-covered dugouts, or cellars, which are designed to provide adequate ventilation and to prevent freezing. Dugouts are usually large enough to store several carloads of potatoes and are provided with a passageway for trucks.

Potato-seed production is becoming more and more restricted to drylands of northern areas Potatoes grown in dryland are less subject to fungus infection, are a better size for planting, and usually sprout better

Sugar Beets

Although 23 of our 48 states now grow sugar beets successfully, it was not until near the close of the nineteenth century that the beet-sugar industry became permanently established in the United States During the World War period, the industry had a phenomenal growth Near the close of the nineteenth century, only 30 beet sugar factories were in operation, by 1936 a total of 99 factories had been established In number of sugar-beet plants the western states lead, Idaho with nine is in fourth place among the states. Montana has four, Washington 2 (only one in operation), and Oregon one

Sugar beets are tolerant of a wide variety of soils, and are grown at elevations varying from sea level to as much as 5,000 feet Because of their unique resistance to alkali, sugar beets are especially well adapted to arid regions which have been reclaimed by irrigation.

The beet crop is of special significance in the intermountain regions of the West The refining of beet sugar is done in or near the growing regions, thus saving the expense of a long haul to market. It is also a cash crop, the price of which is partially determined by contract arrangements with sugar-refining companies before the crop is planted. Growers often obtain credit loans from the contracting companies to tide them over the growing season The contractors also aid the growers in other ways such as obtaining suitable seed strains, arranging for harvest labor, and providing expert agricultural advice

Furthermore sugar-beet culture enables farmers to practice more satisfactory crop rotations, whereby soil conditions are improved. Beet by-products, such as beet tops, beet pulp, and beet molasses are fed annually to thousands of farm animals, thus aiding beet-producing areas to expand their number of livestock Over 600,000 feeder lambs from Idaho ranges are now fattened on beet by-products before being shipped directly to market, whereas formerly all feeder lambs were shipped to corn-growing sections. Similarly several thousand head of range feeder cattle are fattened for market. Thus, "the beet grower, remote from the denser areas of population, transforms his crop into two concentrated products, sugar and meat, and ships them long distances at less expense than (he could ship) bulky (agricultural) crops from the same soil."[1]

Successful beet culture requires a growing season of 125 days or more, mean temperature of 70 degrees during the growing season, although light frosts at night are not harmful except when the plants are young and tender, much sunshine and many cool nights during

[1] *The Silver Wedge*, p 34, the U S Beet Sugar Association

the maturing period to produce the highest sugar content, a dry autumn period for harvesting the crop, deep rich loam soils, and a dependable supply of water while the crop is growing

The Snake River Valley plains of southern Idaho constitute the principal sugar-beet-growing area of the Northwest. Although sugar beets are grown in all sections of the valley from Weiser to Ashton, the southeastern section is the greatest producer. Owing to high elevation, cool nights, and short growing season, it is less suitable for raising fruit, hence the emphasis on root crops The Bitterroot and the Flathead Valleys of western Montana and the Yellowstone and Milk River Valleys of eastern Montana also produce large amounts. In Washington producing areas are located near Bellingham, Toppenish, and Sunnyside.

Sugar-beet production in Idaho has increased from 75,000 tons in 1904 to 980,400 in 1939 In contrast with wheat, beet acreage varies widely from year to year, depending on prices. In recent years three factors have tended to stabilize the beet-sugar market and thus to encourage production tariff of 90 cents per 100 pounds levied on Cuban sugar; advertising campaigns which have convinced consumers that beet sugar is identical with cane sugar, prevailingly low market prices for other farm products.

Hops

Hop production is a highly specialized industry controlled by a few large-scale producers. The number of growers is limited, but the industry employs a large amount of labor, especially during the harvesting season. Hop plants will grow in many parts of the United States, but commercial production is centralized in the Pacific Coast States, limited areas of Oregon, Washington, and northern California producing nearly all hops raised in the country.

The hop is a perennial plant which can be raised either from seed or from cuttings, the latter being commonly used. In the Willamette Valley, Oregon, and in the Yakima Valley, Washington, plantings of hop cuttings are made during March and April. Unlike most agricultural crops, hop fields, or yards, do not have to be replanted except at long intervals. The vines are supported by a high trellis system, on posts 10 to 12 feet high. Such trellis work costs about $100 per acre and constitutes an important item of expense to the grower.

The fruit, technically a cone or strobile, is the "hops" of commerce. In the Yakima Valley, most of the picking is concentrated in the month of September. This work affords considerable employment to local

residents, to transients, and to Indians of the Yakima Reservation The Indians come in family groups and camp during the three weeks picking season, over 3,000 of them being employed. As hops are picked, they are put into sacks, which are collected and weighed by the owner Pickers receive about 2 cents per pound, and are able to gather 150 to 300 pounds per day. The average annual labor outlay for the three hop-producing states is about $4,000,000

Hops fresh from the field are carried to kilns for curing. Most kilns are boxlike wooden structures about 30 feet in height, with an inside drying floor some 20 feet above the ground floor Loosely scattered over the kiln floor to a depth of 10 to 24 inches, the hops are cured by the heat from a stove or furnace below, and also bleached with sulphur fumes. The usual curing period is 18 to 20 hours When cooled, cured hops are pressed into 200-pound bales, enclosed in jute bagging, and are ready for shipment.

The Willamette Valley, Oregon, leads in production with 90,000 to 110,000 bales annually California averages 50,000 bales and Washington 40,000 to 50,000 bales Salem is the recognized center for marketing and for distributing hops in Oregon, as well as the leading district in the United States Yakima, Moxee, Toppenish, and Sunnyside grow 80 per cent of all Washington hops Trends since 1929 indicate that the industry in California is decreasing in importance owing to higher labor costs, whereas that of Oregon and Washington is increasing proportionally.

Flax

Flax fiber has been grown in Oregon since early days, when the pioneers used it as a clothing material The chief environmental requirements include (1) abundant rainfall distributed in many light showers rather than in heavy downpours; (2) cool, cloudy weather during the growing season; and (3) deep, fertile, well-drained soils It is almost entirely limited to the Willamette Valley, which is, incidentally, the only real fiber flax center in the United States The five counties which produce most of the crop, together with the number of individual growers, are Clackamas, 84, Marion, 57, Linn, 15; Yamhill, 11, and Lane, 9 (For flax manufacture, see Chapter 23.)

Hardy Seed Crops

Because of high transportation costs of such bulky crops as potatoes and wheat, many farmers have turned their attention to the production of seed crops which carry a high market value per unit weight.

For example, the growing of alfalfa and clover seed has become a profitable industry, especially in southern Idaho, as has the growing of flower seeds in the Puget Lowland and near Victoria, B C

Alfalfa Seed. Alfalfa seed is now an extensive and profitable industry in the irrigated sections of southern Idaho, where fertile soils and favorable climatic conditions help produce seed of high quality which commands a premium price The cool nights and the great amount of sunshine in Idaho cause the development of hardy strains which can withstand the severe weather characteristic of northern states. Alfalfa produces better seed when planted in a crop rotation that follows potatoes and beets, which put the soil in good physical condition. Nurse crops such as barley, wheat, oats, and peas are often planted with seed alfalfa to protect the young plants from the hot rays of the sun The three main varieties of alfalfa seed produced are Grimm, Common, and Cossack

Clover Seed.[2] The demand for clover seed in the United States is much greater than the domestic supply Clover-seed growers, therefore, are practically assured of a profitable price for their product.

Irrigated sections of Idaho are especially adapted to all types of clover-seed production Under the favorable climatic conditions that exist in Idaho, highly colored, good-quality clover seeds can be grown, which are much in demand by eastern buyers Red and alsike clovers are used for both hay and seed, white and ladino are utilized chiefly for seed and pasture The irrigation farmer is able to control the blooming of the plant, and, generally, throughout southern Idaho the critical period of seed production is free from damaging storms, and has an abundance of sunshine It is generally accepted among seed growers that bees especially the bumble bee are essential to an abundant crop of seed.

Oregon has a fodder-seed industry with an annual value of $5,000,000. Vetch, clovers, and alfalfa are all exported, especially from irrigated, high-elevation districts in Deschutes, Crook, Malheur, and Klamath counties. The Willamette Valley produces millions of pounds of lawn grass and fescue seed Bentgrass is grown for seed in sections of the coast province The high value per pound of grass and clover seed, especially when certified, makes possible the profitable transport of small seeds from the Northwest to distant markets.

Vegetable Seeds

Up to the beginning of the World War in 1914 our seedsmen depended upon European countries for a large part of their garden

[2] The term "clover" used in a broad sense includes red, sweet, alsike, white, ladino as well as a number of minor species

seeds Since then the production of garden seed has become important in parts of the United States, including suitable areas in the Northwest.

Since some vegetable plants will produce an abundance of viable seed only if soil and climatic conditions are favorable, the industry is highly specialized For example, most of the cabbage seed is produced in either New York or Washington, turnip and rutabaga seed in Washington and California, and garden peas in Wisconsin, Washington, and Idaho. The northern Palouse section of Idaho and Washington now leads the country in growing seed peas. Beet seed is grown in Oregon, Idaho, and Montana, and near Mt Vernon, Washington. Mt Vernon also raises fine cabbage seed, and has reported yields of 1,000 pounds or more per acre, which is well above the national average. The Lewiston area of Idaho produces onion seed and onion sets. An increased production of vegetable seeds seems quite feasible in favored parts of the Northwest.

Flower Seeds and Bulbs

The growing of flower seeds and bulbs is of increasing importance in the Northwest, particularly in the marine climate west of the Cascades Victoria, British Columbia, is famous for sweet pea seed and parts of the Willamette and Puget Lowlands raise certain flower seeds. The same districts have many nurseries that prepare rose cuttings, shrubs, shade trees, and blossoming trees for planting. Several localities in the Puget Sound district have specialized on Dutch bulbs, and over a thousand acres are planted to narcissus, tulip, and lilies, which are a valuable crop and may bring in one to two thousand dollars per acre Several large producers have a hundred acres or more in bulbs which run as high as a hundred thousand bulbs per acre.

In addition to marine climate and special soil conditions, bulb growing is usually located relatively close to the larger cities such as Seattle and Portland Many bulb and flower farms are also found in the vicinity of Bellingham.

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CHAPTER 19

LIVESTOCK IN THE PACIFIC NORTHWEST[1]

By WILLIS B MERRIAM

Early explorers in the Columbia Basin and in other rich valleys throughout the Northwest commented almost universally upon the vast expanse of luxuriant grasslands, awaiting the day when they would become one of the richest grazing grounds in America. In time these lands were stocked with cattle and sheep, and fulfilled the predictions of the pioneer prophets. Although their first luxuriance is now gone, and the best of them have been plowed for other types of farming, there are still thousands of acres where grazing is dominant. The livestock business is perhaps of special value to the Northwest because it utilizes the thousands of acres of "too" lands—lands too rough, too dry, too mountainous, too wet, too frosty, or too remote from market for any other type of agricultural crop Grazing and certain types of animal fattening are also complementary to other agricultural practices, since they utilize forage crops and waste by-products, such as sugar-beet tops. Grazing and fattening of livestock are so widely scattered over the entire Northwest that in a larger sense the Region may be regarded as one vast animal pasture.

Early Cattle Raising

Although a few head of livestock were brought in by earlier explorers and settlers, the industry really began in the middle 1820's. Cattle raising to supply meat to various fur-trading posts was inaugurated at Fort Vancouver in 1825, and in 1826 small herds made their appearance in the Colville and Okanogan valleys Cattle driven across the plains were a feature of the Wallula settlement in 1824, and it is estimated that 200,000 head were in the Walla Walla country by 1855. The Indian Wars after 1855 caused a reduction in numbers, but during the decades of the 1860's and 1870's cattle again increased with the arrival of more settlers and a growing demand for beef During

[1] Acknowledgment is made of information furnished by J Ford McBain of the Montana State Normal College at Dillon and by R. M. Shaw of the Central Washington College of Education at Ellensburg

the 60's herds were driven into Idaho and Montana, coming from Utah and California. Somewhat later cattle drives of breeding stock came north from Texas. There were two main reasons for the rapid rise of range stock at this time (1) the growing local market centered mainly around military posts and (2) the gold camps of the 1860's in the mountains of Idaho and British Columbia After the decline of this mining market trade, drives of Oregon cattle (as all Northwest stock was called) were made to Nevada and Wyoming for shipment east.

The Diminishing Range

During the early years much of the Pacific Northwest was a free range open to anyone, but markets were few and the business was not particularly profitable. Before 1880 overgrazing became common and the range had already deteriorated. Stockmen were determined to make a fortune while the grazing lasted and a general cream-skimming process followed. Not only did overgrazing and overproduction handicap the cattlemen at this time, but severe winters periodically destroyed the natural increase of the herds on the open range. Tremendous numbers of range cattle were lost during the bitter winter of 1861-1862. The winters of 1885-1886 and 1889-1890 also killed thousands. As a result, the more progressive stockmen began to provide some winter shelter and hay for their stock.

Settlers also took up much of the best grazing land for homesteads, in spite of opposition on the part of the stock ranchers. In Washington desirable free range had almost vanished by 1880 The completion of the Northern Pacific Railroad in 1883, followed by other railroads, helped further to change the business It became easier to ship cattle to market and paid to improve the breeds of stock kept, but the railroad also encouraged settlement by farmers Each new farm and fence crowded out more stockmen, thus hastening the end of the free range in the better areas Here alfalfa fields and permanent haystacks brought a change to pure blood stock and the marketing of baby beef, and caused a shift to dairy herds.

Conditions Favoring the Livestock Industry

Except on the western slopes of the Cascades and Coast Ranges, the Pacific Northwest is characterized by a limited rainfall and generally low humidity. The dry climate and moderate temperatures of the interior plateaus, desert plains, and mountain pastures are on the whole favorable for livestock Except in high mountains the snowfall is

CATTLE IN NORTHWEST STATES

	(1870)	(1880)	(1886)	(1941)
Idaho	50,000	193,000	220,000	821,000
Montana	117,000	622,000	1,050,000	1,273,000
Oregon	374,000	631,000	628,000	1,042,000
Washington	106,000	207,000	269,000	876,000

(The estimates for 1941 are from Agricultural Development Department, Northern Pacific Railway)

moderate, sleet storms seldom occur, and animals require little or no shelter even when temperatures become quite low, although hay or other forage must be supplied in cold or snowy weather. Untilled grasslands, open woods and forest meadows, wet pastures, and both irrigated and dry agricultural lands make their contribution to the livestock industry. Census figures indicate about 165,000,000 acres of land in the area encompassed by this study of which only about one-tenth is actually in crops The percentage of all land in farms in the states comprising the region ranges from about 16 per cent for Idaho to 32 per cent for Washington The balance is made up of National Forest, Indian reservations, National Parks, unappropriated government land or miscellaneous privately owned lands, much of it also used for grazing.

Present Grazing Area

In Idaho, of 53,346,560 acres of land in the state, about 20,750,000 acres (39 per cent) are classified as grazing land, including about half of the 9,140,000 acres in "farms." In proportion, Washington has less grazing land than the rest of the Northwest, of its 42,775,040 acres, about 13,500,000 acres are in farms (32 per cent), of which 6,000,000 acres provide grazing There is very little usable open range in Washington, but considerable forest pasture, both publicly and privately owned, is available In Oregon, with 61,188,480 acres, one quarter (25 8 per cent) of the state's area is public domain, located mainly in the dry central and southeastern sections, and most of this is range grazing land. Nearly half (43 per cent) of Oregon is privately owned land, of which 16 per cent is crop land, 43 per cent is timber land, and 38 per cent is grazing land. In addition, there is grazing in National Forests, which cover 22 per cent of the state, on certain Indian Reservations, and on state and county lands (the latter taken in part for delinquent taxes) located mainly in central and southeast Oregon. Nearly 28,000,000 acres in Oregon are available for grazing.

Including mountainous western Montana, probably 70,000,000 acres of the northwestern states are predominantly used for grazing. This

does not include the thousands of acres similarly used in southern British Columbia.

Decline in Carrying Capacity

It should be noted that the area available tells only part of the story since the carrying capacity of the range varies widely. Feed for one cow may be provided by an acre of wet pasture or one hundred acres or more of semidesert herbage. Where serious deterioration of the range has occurred, the carrying capacity may be only one-third of what it was originally Government surveys indicate that virgin forage has had an average decline of 68 per cent in southern Idaho and 65 per cent in eastern Oregon. A survey by the Federal Land Bank of Spokane shows that the range in the mountain counties of western Montana has deteriorated an average of 56 to 63 per cent. Where formerly two or three acres of virgin grazing land per month sufficed to feed one cow, now five to eight acres are needed Naturally this depletion has materially decreased the carrying capacity of the area The greatest degree of depletion, 74 per cent, is in the subalpine meadows, according to the Regional Office of the Forest Service at Missoula (See also Chapter 6)

Income from Livestock

Farm income in 1940 for the four northwestern states (including all of Montana) was $223,600,000 from crops and $221,800,000 from livestock.

FARM INCOME 1940

	From Crops	From Livestock and Animal Products
Idaho	$ 42,883,000	$ 47,933,000
Montana	47,716,000	49,757,000
Oregon	49,556,000	60,292,000
Washington	83,444,000	63,821,000
	$223,599,000	$221,803,000

While dairy produce is included in the totals shown by the table, the income from sale of beef, mutton, pork, and wool totals well over $100,000,000 per year for the area included in the Northwest From the range, taken by itself, livestock operations provide approximately 20 per cent of the agricultural income, running as high as 40 per cent in Montana, 21 per cent in Oregon and Idaho, and 5 per cent in Washington.

Present Livestock Conditions

From the standpoint of value, although not in numbers, beef cattle

represent the leading feature of the Northwest livestock industry. Some 800,000 beef cattle, with an assessed valuation of $65,000,000, are to be found in this area. Cattle are rather evenly divided over eastern and southern Oregon, the less mountainous parts of Idaho, southwestern Montana, northeastern Washington, the valleys and plateaus of southern British Columbia, and the Scablands, semideserts, and rough uplands of the Columbia Plateau. The lowlands in western Washington and Oregon and the rugged Northwest mountains are minor areas of production. Dairying and general farming sections on both sides of the Cascades send a certain number of beef animals to market every year.

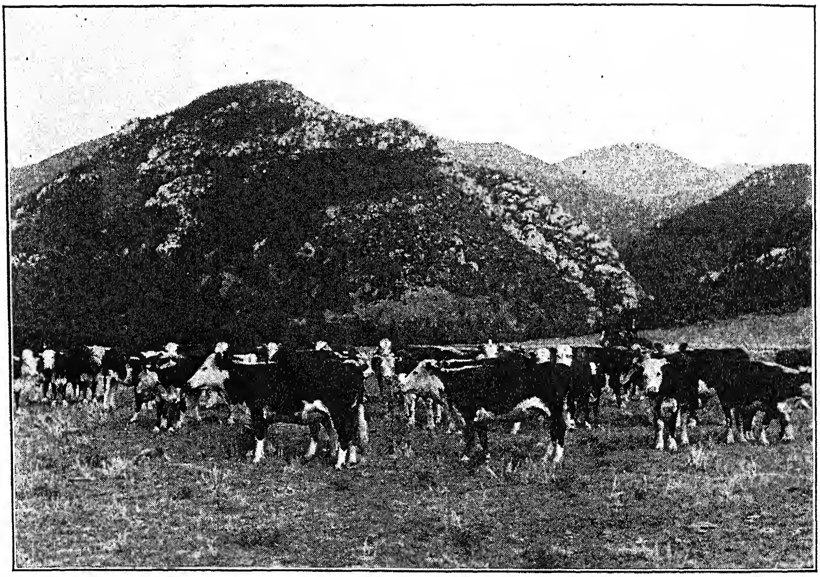

FIG. 116. Cattle and range in western Montana. (*Courtesy Northern Pacific Railway.*)

Beef Cattle

The beef-cattle industry has undergone a number of changes in recent times. The former practice was to stock the range to the limit of carrying capacity and keep the steers on pasture until they were three to five years old and weighed 1,300 to 1,600 pounds. Present market demand favors undermature animals, yearlings, and two-year-olds averaging 900 to 1,200 pounds, suitable for quality cuts of meat. Stock of this type require more and better fodder especially during the winter. The number of animals on the range has not changed appre-

ciably for a quarter of a century, however, indicating that the industry has become fairly well stabilized.

While beef prices rose sharply during the World War period of 1914-1919, taxes and other expenses also increased so that the livestock business was not as generally profitable as in earlier times Since 1915, the range has suffered from decreased rainfall. In addition to drouth with its resultant shortage of hay and grass, price fluctuations and other economic conditions have handicapped both sheep and cattle men International as well as local factors also affect the business at times Predatory animals formerly killed large numbers of sheep and cattle, especially young calves and lambs, but bounties and government hunters have largely eliminated danger from the predators.

Carrying Costs

In the days of the open range a steer could be raised for as little as $3 00 per head per year, but costs at present are three times that amount. About forty acres of range is required for a cow per year and eight acres for a sheep. The average grazing season in the mountain counties is seven to seven and one-half months, and the feeding period is about four and a half months. Hay is the usual winter feed, prices averaging $6 00 to $8 00 per ton. Estimates of the cost for cattle feed on a ranch carrying 500 head total $11 50 per animal per head per year in southwestern Montana, not counting labor and overhead expenses. When the value of a two-year-old heifer is about $50 and of a two-year-old steer, $65 to $70, the income is sufficient for wages and profits above expenses to the owner Comparatively little hired labor is required on a stock ranch compared with most farming operations A range cattle country needs only a sparse population in contrast to the large acreage of its farm units.

Range Management

Overgrazing, with its resulting lack of feed and deterioration of the range by erosion, is one of the greatest problems for the stockmen Natural rehabilitation of the better native grasses is an extremely slow process, and it may not be economically feasible for private owners to seed their land with grasses Poisonous and nonedible species of plants tend to increase with overgrazing. To help rehabilitate the Public Range and ultimately improve conditions for livestock, Congress passed the Taylor Grazing District Act in 1934 Under the Taylor Act the Administration proposes to conserve Public Domain range resources by a system of temporary permits and by reducing the grazing

animals in a district to the number which will permit maintenance and improvement of the native herbage Prices of permits are 5 cents per cow per month and 1 cent per sheep per month The districts are managed by local boards of stockmen, and the effort is a worthy attempt towards range stabilization and improvement.

Sheep in the Northwest

The number of sheep in the Pacific Northwest totals nearly 6,000,000 head, Idaho and Oregon having over 2,200,000 head each Southwestern Montana is also a leading sheep district It is a common practice to stock with dual-purpose breeds, Rambouillet or Hampshires Sectional transhumance, using the lowlands for winter ranges and mountain forest pastures for summer grazing, is the common system. In eastern Oregon sheep winter in the lower valleys, where feed has been stored, or graze on semidesert herbage In summer the flocks are taken into the Blue Mountains, eastern Cascades, and other ranges for several months of green pasture Cattle use the western Cascades and Klamath Mountains and compete with sheep in parts of the Blue Mountains Sheep utilize mediocre grazing to better advantage than the cattle and tend to replace cattle on poor pastures In Washington sheep are winter-fed in largest numbers in the Yakima and Kittitas Valleys. The Columbia Basin serves as winter range for flocks of sheep, which in summer are commonly taken to graze in the southern Cascades and Okanogan Mountains.

Crosses. The range-sheep industry centers around the ewes that produce fat lambs for July and fall shipment to packing centers and supply wool in the spring. Crossbred stock is preferred, a favorite cross in Kittitas County being between Rambouillet ewes and Lincoln or Romney Marsh rams. Either cross produces prolific ewes that herd together well and have heavy fleeces of excellent-quality wool. Their large lambs and the mothers themselves both supply a high quality of meat. The ewes are kept for 6 to 7 years They are commonly bred to Hampshire rams, and the fat lambs sold at five months of age weigh 85 to 95 pounds apiece.

Transhumance. Within the boundaries of Kittitas County, Washington, are all necessary types of feeding areas for range sheep.

In the fall, the animals may be grazed on the irrigated pastures of Kittitas Valley, agricultural heart of the county Then, as winter approaches they can be moved eastward to the sagebrush and grass-covered slopes that descend to the Columbia River. In spring the foothills to the north, west, and south of the valley provide range. For

summer feeding there are the National Forests in the high mountains on the west and north.[2]

Five life zones of different plant associations are grazed sometime during the year. The lowest in elevation is the bunchgrass and sagebrush in the Columbia and Kittitas Valleys. Above the prairies, to about the 4,200 foot contour, are an open forest of yellow pine, a zone of Douglas fir, larch, and lodgepole pine, and a sub-alpine belt of stunted timber that lies between 5,000-7,000 feet elevation. All three forest zones contain bushes, weeds, and grasses that provide excellent spring and summer browse for sheep. Above the timber of the zones below, are high alpine meadows available for feed during several weeks of the summer.

The Summer Range. Some summer range is owned by sheepmen, but most of it must be leased from the government or railroad and logging companies Owners can graze sheep in National Forests only on their allotments. Nearly all the grazing has been leased and the establishment of recreational areas in the National Forests has reduced the land available for sheep Regular driveways connect the various allotments. The Forest Service limits a band to 1,250 ewes and 1,500 lambs Other restrictions intended to protect the forests and scenic beauty prohibit a band from bedding in the same spot more than one night, from grazing within a quarter of a mile of a highway, and from bedding down near running water that might become polluted Also a herder must leave at least 25 per cent of the palatable vegetation. The average season for the grazing of sheep in National Forests is from June 15 to September 15 A fee of 4½ cents a head per month is charged for sheep grazing. In July the "top" lambs are sent to market, being trailed down to a corral for loading in a truck for transport to Seattle or to the nearest railroad stockpens for shipment East.

Sheep Herding. The herder, who must be a very faithful individual, rarely keeps his herd of sheep in one locality for over one week. He is assisted by a packer who brings in salt for the sheep, and food for the two men, and by several dogs without whose aid herding sheep in large bands would be nearly impossible, since a dog accomplishes at least as much work as a man and does the job more quickly.

The cultural forms connected with the range sheep industry are, in the words of Dr. Shaw,

> . . . shiftlessly picturesque rather than substantially impressive Corrals are make-shift affairs quickly arranged in any suitable pattern by

[2] R M Shaw, in his unpublished manuscript, *The Sheep Range Industry of Kittitas County*, supplies much of the following information about range sheep

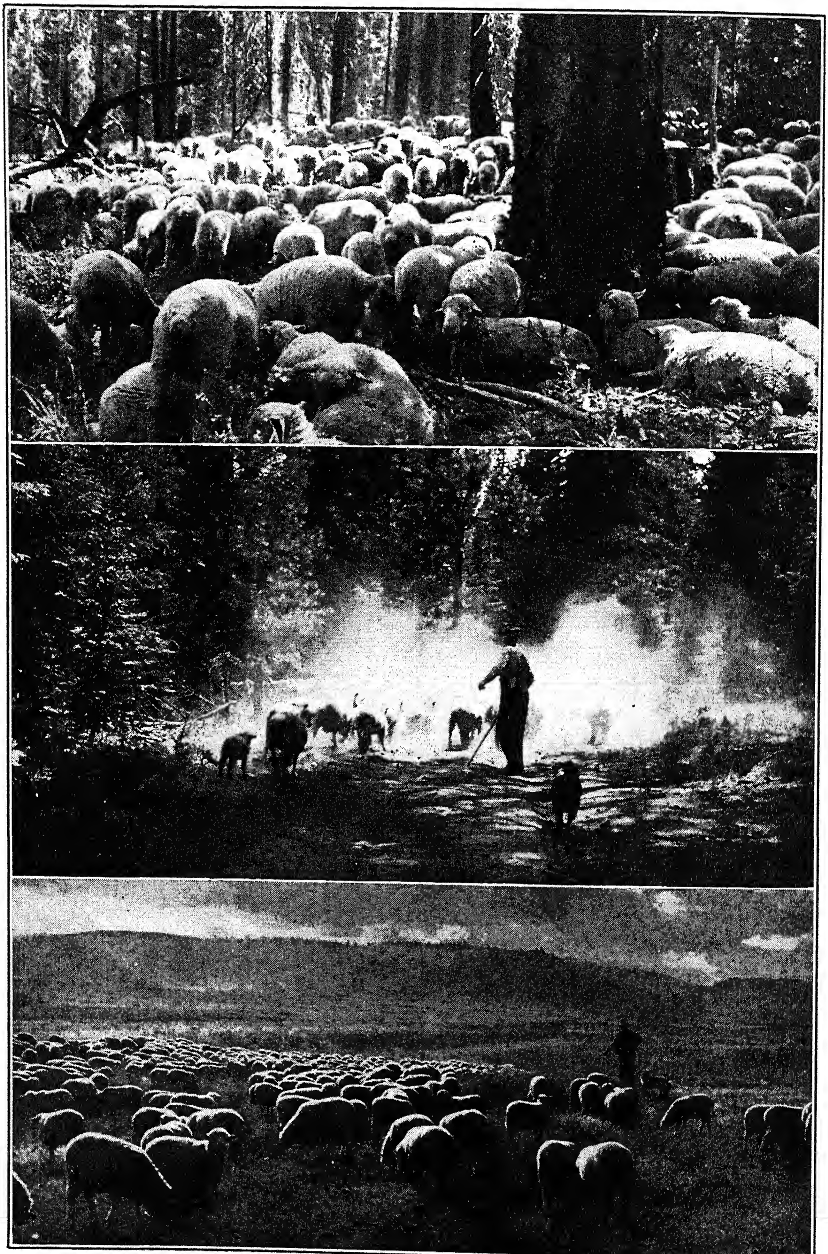

FIG. 117. *Upper:* Sheep on mountain pasture during the summer. *Middle:* The sheep herder and his dog drive a band to the summer grazing grounds. *Lower:* Fall pasture in wheat stubble. (*All photographs by Mary MacLennon.*)

merely wiring wooden panels to poles quickly driven into the ground and frequently supported by boulders Sheds, unpainted and weather-worn, stand in varying stages of dilapidation The home of a herder may be a canvas-covered wagon in open country, a tent at any season or a shack or abandoned farm house if he is to remain in an area for some time as when on the winter range. More vital than imposing structures are good ranges and ewes. Although the range sheep industry involves thousands of acres of land its imprint is but lightly stamped upon the landscape. People are scarcely cognizant of its presence, except in the fall when the sheep are on the valley pastures.

Idaho a Sheep Center. Sheep constitute the major livestock of Idaho, 22 per cent of all farms in the state keeping sheep. In southern Idaho farm flocks of 50 to 100 sheep have proved a valuable means of utilizing surplus feeds and such by-products as beet tops, grain stubble, and bean and pea straw. Some farm flocks are also found in Oregon and Washington, and more could be kept on feed that is now largely wasted.

The range sheep business is carried on primarily for mutton production, the lamb crop representing the greatest source of income. In general, income from lambs and mutton is twice that from the sale of wool. While the sheep business is carried on primarily for mutton, the wool is an important item providing about one-third of the revenue. Lambs are fattened especially in the irrigated sections where there is an abundance of alfalfa hay In the neighborhood of the Idaho beet-sugar factories, extensive use has been made of beet pulp as a priming feed Range lambs weighing about 60 pounds are sometimes primed to about 85 pounds before being shipped to Chicago, Omaha, or local West Coast markets Three-fourths of the lambs are shipped from the range, and the rest are fed on fall pasture or in winter feed lots A sheep ranch usually handles between 2,000 and 3,000 head. In Idaho there are over 800 ranches carrying flocks which average 2,500 sheep The whole of southern Idaho is a sheep-raising area with the chief feeding sections in the southeast, the eastern Snake River plains, and the irrigated land west of Boise In the summer 1,325,000 sheep graze in the National Forests, mostly in central Idaho.

Value and Future. The annual wool clip of the Northwest totals nearly 80,000,000 pounds, worth around $16,000,000, with Idaho, Oregon, and southwestern Montana in the lead Washington and British Columbia are significant but minor areas. The fact that sheep produce two money crops per year, lambs and wool, and can utilize poorer feed than cattle often makes them a better economic risk than cattle.

Although some flocks of fine wool merino sheep are kept in the Northwest, mutton breeds and mixed breeds for both wool and mutton are preferred over the smaller pure-bred merino The range sheep industry will probably continue to be about as important as at present, but there would seem to be room for an increase in small flocks for farm use that would consume fodder and by-products now largely wasted.

Swine

Visitors from the Middle West are invariably surprised at the minor role of swine in the farm economy of the Northwest. It is possible to ride for scores of miles through agricultural areas without seeing more than an occasional scattered herd of hogs Lacking rich cornfields for use in fattening, the Region feeds only some 500,000 to 600,000 hogs annually, valued at about $4,000,000 The leading centers are communities with grain, dairy, and fruit farms, where hogs are a valuable means of utilizing feed materials otherwise wasted

In dairy centers where skim milk is a by-product pigs can be fattened to very great advantage Field peas, cull potatoes, fallen fruit, pumpkins, and other concentrated field crops such as the cheaper grains are all utilized to produce pork. Little farmers and part-time mill and logging workers with small garden patches use kitchen waste to fatten a few animals each year. Near the larger cities garbage is collected for use in "piggeries" One of the most successful practices is the use of thousands of acres of alfalfa, which furnishes excellent pasture for hogs, the green feed being supplemented by grain The limited corn crop is frequently augmented by imports of this grain.

Market demands for hogs in the Pacific Northwest are in excess of the local supply, and additional shipments are made from eastern Montana and even farther to packing plants in Portland, Seattle, and Spokane. In some parts of southwestern Montana there are numerous ranches that keep thirty to forty brood sows and raise several hundred pigs for sale annually Some ranches secure two litters of pigs per year. Barley is the principal feed used in Montana for the fattening of swine In eastern Idaho feeder hogs can be produced cheaply and are sometimes shipped from there to the Corn Belt for fattening The raising and fattening of more pigs would seem to offer an opportunity to the local farmer, practices which should increase in the future, with more intensive and specialized agriculture attendant upon expansion of irrigation.

Horses and Mules

Horses, in the Northwest, number upwards of 600,000 and are fairly

evenly divided among the states They have declined nearly one-half in number and value since 1910, owing to increased use of power machinery on farms. This decline reached bottom about 1925, and since then the number has remained about the same Horses are not raised systematically on a large scale, but many farmers keep mares to work, and have a few colts every year to sell or later break to harness for their own use They can in this way raise colts at a cost low enough to discourage the professional horse breeders. The only stockmen who make it an exclusive business are those located in the range districts where winter feed is too scarce for other types of stock raising There is a small but steady demand for mules as some farmers prefer them. Moderate numbers of mules are bred, and sometimes imported, for sale. A few race horses are produced in the irrigated sections to meet a limited demand.

Goats

In some parts of western Oregon goats are kept on fenced land to help clean up brush and make land clearing easier A few milch goats are found near most of the main cities Since goat's milk is highly recommended by dieticians and sells at a good price, and the goat needs comparatively little feed, it might be used to advantage on more small sustenance and part-time farms

Future of Livestock

The days of cheap cattle and low-cost sheep, produced on the open range, are now gone, but opportunities for the continuation and limited expansion of livestock raising are still available in the Northwest Planning for efficiency and integration with other industries is highly desirable Many parts of the Northwest are essentially livestock regions and will remain so because of immense quantities of available feed Grass and hay cannot be used directly to support people and must therefore be converted into livestock if they are to serve any useful purpose. The combination of suitable soil and climate, large amounts of pasture, sufficient water supply, skillful management, and adequate markets seems to assure the Pacific Northwest of a reasonably secure future as a livestock section Livestock is slaughtered and the carcasses are processed, both for local sale and export, in packing plants in Seattle, Spokane, and Portland, providing a convenient market for small-scale producers who may deliver their animals by truck to the stockyards In addition to the large plants in the three leading cities, slaughter houses in many other cities and towns purchase livestock locally and sell the meat in near-by communities.

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CHAPTER 20

THE DAIRY INDUSTRY

By William H Pierson

Place of Dairying in the Northwest Economy

As a source of revenue to the residents of the Pacific Northwest dairying is exceeded only by the total of all field crops and by the lumber industry. Primary milk production is the largest single source of cash farm income, sales of milk and butterfat amounting to about $68,000,000 yearly. When to sales are added the $14,000,000 of milk consumed upon farms, the income from dairy animals sold for meat, the manufacture of approximately $54,000,000 of dairy products, and the revenues from wholesale and retail distribution, the role of dairying in the Pacific Northwest assumes major proportions. According to the census a total of 488,000,000 gallons of milk was produced in the three Northwest states in 1939

Approximately 15 per cent of all Northwest farms are classed as dairy farms,[1] but the operators of several thousand farms classified otherwise are engaged in dairying as a major activity in combination with such enterprises as poultry, fruit growing, and general farming. Milch cows are kept on about 155,000 farms, or 87 per cent of all farms within the Pacific Northwest To these primary producers must be added approximately 2,000 persons employed in factories making dairy products, and the hundreds of others engaged in marketing and handling activities

Correlation with Climate

The climate of the Pacific Northwest is generally favorable to dairy cattle, especially the breeds which were developed under similar conditions in northwestern Europe The temperate marine climate of western Washington and Oregon, with its mild rainy winters and long cool summers, is essentially the counterpart of the climate in which the Jersey, Guernsey and Holstein breeds had their origins. These breeds

[1] A dairy farm, according to Bureau of Census usage, receives at least 40 per cent of its income from milk or dairy produce

are at their best in the marine Northwest, milk production per cow is high, and expenditures for shelter and winter feeding are low.

East of the Cascades temperature conditions are less ideal although favorable in general. Winters are severe, but less severe than those of the highly developed Great Lakes dairy belt. In eastern Oregon, in the Snake River plain, and in the Columbia Basin summer temperatures during two or three months of midsummer are too high for maximum milk production, although wherever irrigation has overcome the limitation imposed by aridity, dairying can be practiced efficiently.

Factors Affecting Regional Distribution

The distribution of the 800,000 dairy cows in the Pacific Northwest is influenced by a complex of factors, chief of which are (1) quality of pasturage, (2) the availability of feedstuffs, (3) the competition of other farm enterprises for land and labor, and (4) the proximity to urban markets.

Good pasturage is naturally abundant in the rainy sections west of the Cascades, and can be efficiently provided in the irrigated areas east of the Cascades. In the dry farming sections of the interior, pastures are poorly suited to dairy needs, with the result that milch cows are kept in small numbers, frequently only one or two on a farm, and these often of beef type or mixed breeds. Hay crops as well as pasture grasses flourish west of the Cascades and in the irrigated sections, but, within the dry farming sections, they are inadequate to sustain genuine dairy development. Even in the irrigated sections the high costs of land and water tend to favor use of cropland for more intensive purposes such as orcharding, except in the immediate vicinity of urban centers and in certain districts more suited to dairy purposes than to horticulture.

The grain feeds are readily grown at moderate cost in nearly all parts of the Northwest except in the rain-soaked coastal region; here the lush growth of grass for pasture and hay offsets the deficiency of concentrated feedstuffs.

The Puget Sound Lowland

The lowland of western Washington between the Cascades and the coastal mountains is the prime dairy region of the Pacific Northwest, with six of its ten leading dairying counties About 70 per cent of the milch cows of Washington are found here

Climatic conditions closely approximating those of the best dairy countries of Northwest Europe, large urban markets near by, and

TABLE 22

Dairying in the Pacific Northwest[a]
(1937)

	Milch Cows on Farms	Milk Production per Cow	Total Milk Production on Farms (Millions of Pounds)	Farm Value of Milk and Butterfat Produced[1]	Per Cent All Farms Classed as Dairy Farms[2]
Washington	316,000	6,030 lb	1,905	$36,195,000	17 9
Oregon	247,000	5,410	1,336	26,052,000	14 7
Idaho	185,000	5,500	1,018	15,983,000	10 1
Western Montana	46,000[3]	4,210[4]	193	3,651,000	13 5
Pacific Northwest	794,000	5,287	4,452	81,881,000	14 8

[a] Publications of U S Department of Agriculture and Census, 1930
1 Value all milk sold and used on farms for all purposes
2 1930 figures
3 Estimated on basis of distribution given in Census of Agriculture, 1934
4 State of Montana as a whole Production in Western Montana is probably higher

agricultural conditions more favorable to intensive use of cropland than to general farming, all combine to favor dairy specialization. Precipitation which ranges from 30 to 50 inches is ample for rich pasturage and hay crops A tendency to drouth during two summer months is largely offset by the seepage received in the alluvial soils on which most farming is done. The dryness of the summers permits the growing of oats, wheat, and corn for fodder, thus providing a well-rounded supply of feedstuffs Not entirely self-sufficient, this lowland imports some grain from eastern Washington.

The best agriculture is in the valleys of the numerous rivers crossing the lowland. Many upland farms on relatively sterile glacial till are found in the vicinity of the larger cities. These small part-time farms producing small amounts of milk are a response to adjacent urban markets, and often to the desire of urban workers to enjoy ample living room while supplementing their income.

Valley farms are usually small, owing in part to the high cost of preparing cut-over land Stump removal costs more than the initial purchase price of good raw land, and clearing is usually prolonged over many years of farm occupancy Only in the oldest farming sections are fields completely free of stumps, and a tract of "stump pasture" occupying good land is common to most farms. As the result of the high value of cleared lands, agriculture is specialized and inten-

sive. Dairy farms containing more than 80 acres are few and most have between 30 and 70 acres, a very satisfactory size for this type of farming

A typical dairy farm in Whatcom County, leading dairying county of the Northwest, contains 48 acres, of which about half is cropped Clover, timothy, and ryegrass, usually grown together and used interchangeably as meadow or pasture, occupy 15 to 18 of the 24 acres cultivated. Oats, for grain or cut for green feed, occupy most of the remaining acres cropped Corn for forage, a potato patch, a family garden and orchard utilize small acreages. The uncleared portion of the farm is thick woods or stumpy noncrop pasture of low carrying capacity. The dairy barn is usually larger than the modest dwelling and houses some fourteen to eighteen cows. Cows are well-selected grade Guernseys, Holsteins, and Jerseys. Many dairy farms include poultry as a sideline or perhaps as a major enterprise of equal importance.

This is a region of high specialization, good farm techniques, and well-organized marketing services. More than 65 per cent of the milk is sold as fresh market milk, Seattle and Tacoma taking the greater part of it. Many creameries and condenseries together with a few cheese factories make this region also a heavy shipper of all types of dairy products.

Willamette Valley

The fertile and long-settled Willamette Valley is the most important agricultural region of Oregon, and one of the two dominant dairying regions of the Pacific Northwest. Here are found five of the ten chief dairying counties of Oregon and four of the first twenty dairying counties in the Pacific Northwest.

This region differs from the Puget Sound Lowland in several ways. Here is found a broad expanse of level farmland. Soils are more fertile than all but the best alluviums of the Puget Sound Lowland. Winters are colder, although not severe, and summers are warm and dry. Although annual precipitation ranges between 40 and 50 inches, summer drouth is sufficiently pronounced to limit the season of natural pasturage to about three and one-half months. Supplemental irrigation, by which the pasture season is lengthened to six or seven months and the hay crop improved, is now increasing Summer drouth necessitates considerable grain feeding.

Instead of the specialized milk production found in the Puget Sound Lowland, general farming prevails. More than 80 per cent of

all cropland, however, is in pasture, hay, and grains like wheat, oats, corn, and barley—crops basic to dairying.

Dairy farms average 155 acres, with about 80 acres in crops, most of the remainder being brushy pasture. Such farms average about fourteen milk cows. Many other farms not so classed keep a few cows and add to the regional output. The productivity of cows within the Wil-

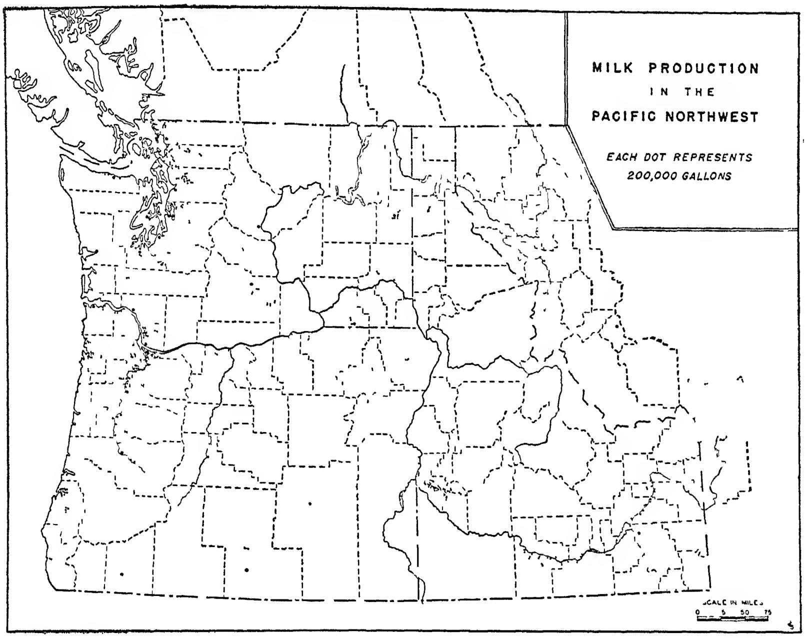

FIG 118 Milk production in the Pacific Northwest

lamette Valley, approximately 6,400 pounds of milk per year, is exceeded in the Pacific Northwest only in the Puget Sound Lowland.

The greatest density of dairying is found in the vicinity of Portland, which, with 31 per cent of the population of the state, is the one large urban market within Oregon. Its milk comes from some 770 dairy farms in four adjacent Oregon counties as well as from Clark County across the Columbia River in Washington. A number of smaller cities down the valley have their own local supply districts.

Coastal Region

Climatically the narrow fringe of lowland in Oregon and Washington between the Coast Range and the ocean is the Ireland of the

Northwest. All-year coolness and heavy and persistent rainfall favor lush growth of grasses on plowlands and tidal flats, but virtually prohibits the ripening of grain. Even the curing of the grasses which grow so abundantly is difficult because of the high humidity and fogginess of late summer, the least rainy season

The short valleys facing the sea and separated by mountain spurs contain all the cropland, and dairying is almost the only type of agriculture commonly practiced Nearly every farm keeps cows, the percentage classed as dairy farms being higher than in any other section of the Pacific Northwest.

This is a region of specialized pasture dairying, based upon rich grazing for seven or eight months Practices are adjusted to the advantages and limitations of the environment, cows being freshened in spring for peak production during the long pasture season when feed is abundant and labor demands are at a minimum. To economize on hay and grains, milk production is allowed to slacken during the four or five winter months. Much hay and virtually all feed grains must be purchased outside. The yearly average per cow of 6,000 pounds of milk is exceeded only in the Puget Sound Lowland and Willamette Valley regions.

Farms are typically of "family size" and, although often containing large acreages of uncleared or rough mountain land, have only 30 to 35 acres in crops As in the Puget Sound Lowland stump and brush removal costs between fifty and one hundred dollars per acre so that only the alluvial soils are cropped; despite its use for grass only, this land is valued at $150 to $400 per acre

The lack of large urban markets for fresh milk and the marked seasonal character of production result in the sale of the bulk of the milk to cheese factories and creameries. Tillamook and Coos counties, in Oregon, are noted centers of cheese making Pacific County, Washington, is a lesser cheese center. Throughout this region there are at least three times as many cheese factories as creameries.

Irrigated Districts of Eastern Washington

The chain of irrigated districts strung along the base of the Cascades from Okanogan County to Klickitat County, thence eastward to include Walla Walla County, contains the major portion of the dairying of eastern Washington. In this region of low rainfall dairying is almost entirely limited to the irrigated sections. Alfalfa hay and cheaply obtainable grains provide suitable feeds, but high summer temperatures

and dust-laden winds render the production of high-grade dairy products more difficult than in western Washington.

In this irrigated region crop-specialty and fruit farms prevail, but each district contains a number of dairy farms, especially near urban centers, dairying is dominant over considerable areas in Kittitas and Yakima counties. Farms of all types have cows for home milk supply, and dairying is a well-developed sideline on many of them The feasibility of dairy operations on irrigated land in competition with high-value specialty crops is largely determined by the cost of land and water and the market value of alfalfa hay sold as a cash crop. Dairy farms tend to occupy the less valuable irrigated lands, as well as valley bottoms where frost constitutes a fruit risk, they often contain uncultivated land usable for dry pastures during the spring months.

Yakima County is the regional leader, producing about 14,000,000 gallons of milk yearly to rank fourth in Washington. Kittitas County is second with 4,500,000 gallons yearly, and Okanogan third. About 20 per cent of the milk is consumed fresh and most of the remainder made into butter.

Northeastern Washington and Idaho Panhandle

Ferry, Stevens, Pend Oreille, and Spokane counties, in Washington, together with Kootenai and Bonner counties in Idaho, comprise a dairy region in which many farms are "nonirrigated." In the scablands, hills, and mountain valleys precipitation of 20 to 30 inches favors pasture hay and forage crops. Farms are large and usually contain much woodland pasture of moderate carrying capacity. Milk production per cow is lower than in the irrigated districts east of the Cascades.

Dairy farms are located in valleys having transportation facilities for marketing milk and cream in Spokane, the largest single center of butter manufacturing in Washington Spokane and Stevens counties, ranking eighth and tenth respectively in Washington, are outstanding within this region.

Snake River Plain

With the exception of the small amount in the Panhandle, Idaho dairying is on irrigated land where abundant alfalfa, hay, and excellent pastures are augmented by large quantities of by-products such as beet tops, pea-vine silage, and cull potatoes. The broad Snake River Plain contains three rather distinct dairy sections, all based upon irrigation but differing in intensity

The Boise Valley of Canyon and Ada counties is the outstanding

dairying section of Idaho These two counties, ranking fourth and seventh in the whole Pacific Northwest, contain more than one-fifth of all milch cows in Idaho The fresh milk demand in Boise, Nampa, Caldwell, and smaller towns supports many dairymen, and their surplus goes to the factories.

In the middle Snake River Plain dairying is a major agricultural activity in Twin Falls, Gooding, Jerome, Cassia, and Minidoka counties. Twin Falls leads in milk production and ranks among the first twenty dairying counties of the Pacific Northwest.

In the upper Snake River Plain dairy farms are thinly dispersed over the area. Milk as a sideline on farms growing potatoes, sugar beets, and seed peas is sufficient, however. to run creameries and cheese factories in most of the larger towns.

The only noteworthy area of irrigated dairying in Idaho outside the Snake River Plain is in Franklin, Bear Lake, and southern Bannock counties in the southeastern corner of the state. Here in high intermountain valleys much milk is produced in connection with hay, grain, poultry, and range livestock In a small area extending from Franklin County into Utah dairy farms are the dominant type.

Valleys of Western Montana

Agriculture in western Montana is limited to the floors of the several elongated valleys between the north-south mountain ranges. Here environmental factors both favor and hinder dairy activities Because of high altitudes and remoteness from moderating oceanic influence, winters are most severe within the Pacific Northwest. Farms lie between 2,500 feet and over 6,000 feet, with 67 per cent of all croplands above 4,200 feet. The growing season is short, varying with altitude from less than ninety to about one hundred and thirty days. A few high districts such as the Big Hole Valley in Beaverhead County produce only grass and hay. Winters, although long and severe, are less severe than in the great dairying states of Wisconsin and Minnesota. Missoula, representative of the major farming valleys, has a January mean temperature five degrees higher than Madison, Wisconsin, and twelve degrees higher than Rochester, in southern Minnesota. Precipitation of only 13 to 16 inches makes irrigation necessary except on a few tracts of naturally subirrigated land.

The irrigated valleys of western Montana put a much greater emphasis upon dairying than is general throughout the state A notable alignment of dairy centers lies in the famed Rocky Mountain Trench, extending from the head of the Bitterroot Valley in southern Ravalli

County, northward through Missoula, Sanders, and Lake counties into Flathead County These five account for nearly 70 per cent of the milk produced in the thirteen counties of western Montana Ravalli and Lake counties rank first and fourth respectively in milk production within Montana, and Ravalli County is the twentieth dairy county of the Pacific Northwest.

Missoula, Anaconda, and Butte receive fresh milk from western Montana valley farms, but the largest of these urban markets contains only 40,000 people. Rural population is likewise sparse in this region of grazing range and large farms Western Montana must therefore sell the greater part of its milk in the form of butter and cheese.

Areas of Local Intensity

Throughout the Northwest there are a number of other centers, mainly in irrigated districts or near cities, where dairying is of some local significance For instance, in the Umpqua and Rogue River valleys west of the Cascades in southern Oregon, some dairying is done along with horticulture and general farming. Here Medford, Grants Pass, Roseburg, and lesser towns afford markets for fresh milk, the surplus going to butter and cheese factories. Also, in the Blue Mountain region of Oregon dairying is of tertiary agricultural importance, but Baker County is the eighth and Umatilla the tenth dairy county of Oregon. The urban markets of Baker, La Grande, and Pendleton draw milk from this region, and factories also take appreciable quantities In many other districts dairying is sufficiently developed to meet local farm and urban needs

Manufacture of Dairy Products

The manufacture of dairy products is well developed in the Northwest. Approximately 80 per cent of all milk sold from farms enters processing plants which make butter, cheese, evaporated and condensed milk, and by-products, aggregating more than $54,000,000 annually.

This is primarily a butter region, production amounting to $40,000,000 annually, in contrast to evaporated and condensed milk valued at $7,000,000 and cheese valued at $6,650,000. In every state butter is twice as valuable as all other dairy manufactures combined.[2] Among the 277 dairy-products plants, there are 168 creameries scattered over the Region, with concentrations in the Pudget Sound and Willamette lowlands, the Spokane area, the Snake River Plain, and the valleys

[2] Ice cream is not included as consistent data are not available.

of western Montana. Washington leads in total output of dairy manufactures and in butter production, although relative to other manufactures butter is of greatest importance in Idaho and western Montana.

Surplus milk, especially during peak production in early summer, goes into condensed and evaporated milk and by-products. Of the twenty large plants, Washington has eight, and Idaho and Oregon six each.

Oregon leads in cheese production, with an annual output worth $3,500,000, Idaho with $2,000,000, is followed by Washington with about $1,000,000. Three-fourths of Oregon's 48 cheese factories are concentrated in the Coastal Region, especially in the Coos Bay and Tillamook areas, with the latter producing over half the state output. Washington and Idaho cheese-making is almost entirely limited to western Washington, southeastern Idaho east from Twin Falls, and the irrigated dairy section just east of the Cascades. Within these sections no town has more than two cheese plants, and factories are widely distributed, receiving surplus milk from every important dairying district.

Marketing of Dairy Products

Northwest dairy products are, in the main, consumed within the Region Butter and cheese find markets in urban centers, while condensed and evaporated milk are consumed in logging camps. Washington, which is estimated to be 1.5 per cent deficient in aggregate dairy production, buys more butter and cheese than she sells Oregon, Idaho, and western Montana are surplus producers, shipping both butter and cheese to California markets. In 1939 San Francisco and Los Angeles took 29,350,000 pounds of Northwest butter, of which 19,547,000 pounds originated in Idaho, and 17,600,000 pounds of cheese, of which Oregon supplied 10,766,000 pounds. The very small quantities of Northwest dairy products reaching eastern markets are offset by cheese imported from eastern dairying states. Special types of cheeses are imported from foreign countries in small amounts.

Because of eminently favorable environmental conditions the Pacific Northwest may be expected to retain its relative importance within the nation as a dairy center. It seems unlikely, however, that Northwest dairying will increase greatly because the Region as a whole is already a surplus producer and selling against stern competition. Expansion will probably be slow, keeping pace with increase in population and exceeding it only as dairy products gain greater favor in the public diet, and competitive advantage in markets

outside the Region is gained by still greater efficiency in production and marketing

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University of Idaho Agricultural Experiment Station Bulletins 214, 215, 216, Moscow.

CHAPTER 21

POULTRY AND MINOR ANIMAL PRODUCTS

By Thomas Hunt

Poultry in the Northwest

Since 1917 the Northwest states have seen a great boom not only in the egg and poultry business but also in such less-known fields as the raising of fur-bearing animals and the production of honey. In fact it is not too much to say that these branches of agriculture constitute one of the major farm industries of the Region. In the state of Washington, and especially in the Puget Sound area, the development of the poultry industry has been particularly rapid Prior to 1917 it was necessary to import eggs to supply the local demand. Now the same area sends out millions of eggs and tons of poultry. In 1929 the output of poultry farms ranked fourth among agricultural products of the state of Washington, only fruit, dairy products, and wheat having greater value.

The 1939 production of eggs by Northwest states was Washington, 50,918,000 dozen; Oregon, 27,484,000 dozen, and Idaho, 14,725,000 dozen.

Whatcom County, Washington, has led the entire Region for several years in output of eggs Other leading Washington counties are King, Pierce, Snohomish, Skagit, Lewis, and Clark in the Puget Lowland and Spokane and Yakima east of the mountains The Willamette Valley and Snake River Plains lead in Oregon and Idaho respectively.

Advantages and Disadvantages. Before Northwest poultry raisers expanded their industry and began shipments to distant markets, the producers in the Puget-Willamette Lowland were somewhat favored in that these local areas, with nearly one million customers, were located far from other adequate sources of supply. On the other hand, the producers were handicapped by the fact that much of the necessary feed was not locally produced in sufficient quantities. This is especially true of Puget Sound, which lacks wheat and corn although green feed is abundant. The long distance to the eastern markets, such as New York, Philadelphia, or Boston, is a considerable handicap since the cost

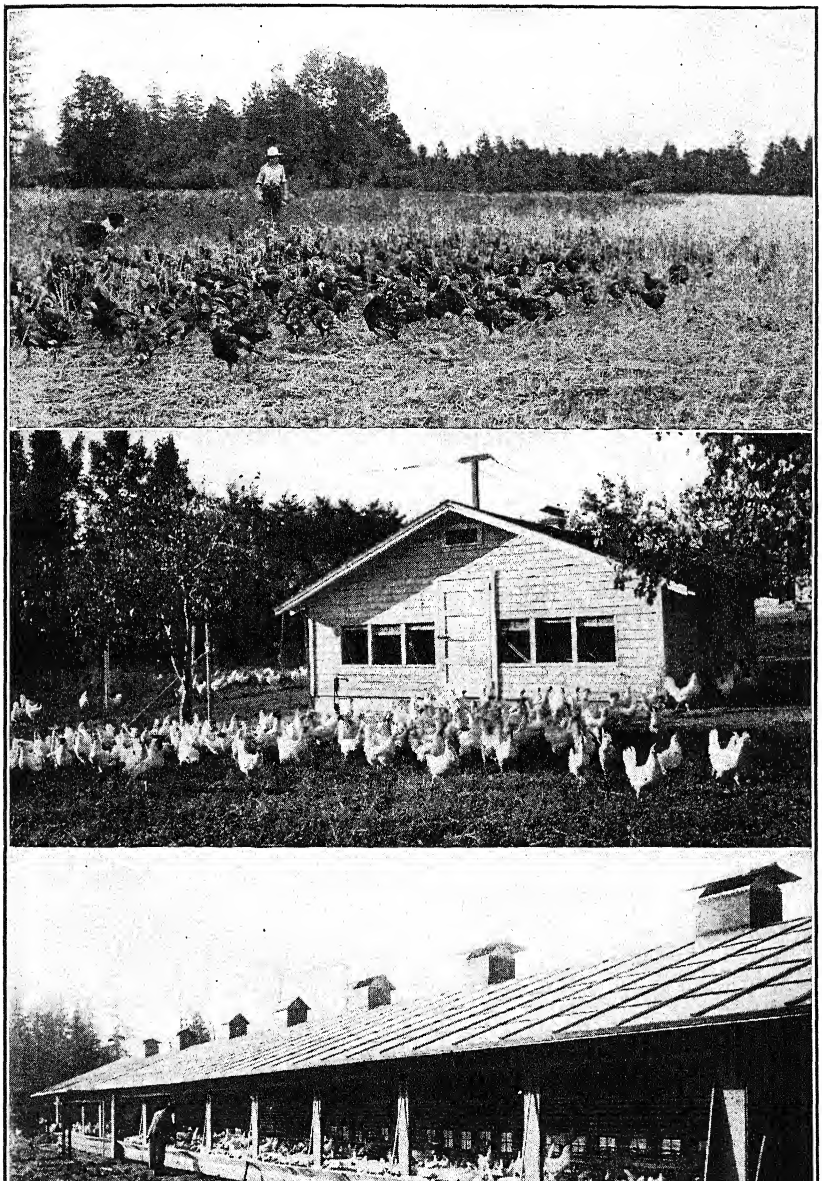

FIG. 119. *Upper:* Flock of young turkeys. *Middle:* Modern poultry plant at Prosser, Washington. (*Photograph by Asahel Curtis.*) *Lower:* Poultry plant near Lynden, western Washington. (*Photograph by Corbett.*)

for freight is about 4 cents per dozen eggs from the Northwest to the Atlantic Coast. On the other hand, the climate of the West Coast gives the poultryman a great advantage in producing fresh eggs in winter, when prices are higher, because production elsewhere is less. Thus the Northwest poultryman figures on making his biggest profit during the winter season A mild winter in the central and eastern states means lessened egg profits for western shippers. Northwest poultrymen endeavor to reach peak production in November, December, and January, at a time when prices are highest.

Poultry Farm an Egg Factory. In addition to naturally favorable geographic factors it is probable that nongeographic considerations have played a major part in the development of the industry The Washington poultry farm in its highest development is in reality not so much a farm as it is an egg factory. The farm, often only a few acres, is the factory site, the buildings are arranged for maximum efficiency, and the hens are the machines which make feed into eggs. Inefficient layers, like inefficient machines, are quickly discarded According to the figures of the United States Department of Agriculture, the average Washington hen lays 149 eggs annually, the highest figure for any state of the Union. Western Washington averages 159 eggs per hen each year whereas individual flocks often average much higher. In the main, the business in Oregon, Idaho, and eastern Washington is not so highly specialized and the average production per hen there is less. The white Leghorn hen, famous for its egg-laying ability, is seen on farms throughout the region.

Co-operative Associations. The Washington Co-operative Egg and Poultry Association has played a large part in the advancement of the industry. Its agents in the large eastern consuming sections study the markets and their requirements. This association furnishes poultrymen with information concerning methods of feeding and care of their flocks It handles and properly mixes much of the feed used by the poultrymen, and also supervises the grading of the eggs and dressed poultry, to assure uniformity of product In the egg-grading process, size, uniformity, appearance, and even color of yolk are considered. The distant buyer of a certain grade of eggs knows exactly what he is to get An organization that can guarantee a uniform product in large quantities has an advantage in securing and maintaining a market, as compared with individuals The railways, eager to secure this profitable shipping business, guarantee that eggs will be delivered quickly and in good condition.

Specialization. Some growers specialize in hatching baby chicks in

incubators and selling them to the general trade. Others specialize in the raising of breeding stock Modern poultry practice includes the scientific early elimination of all cockerels As soon as possible these are sold to feeders who fatten them as fryers for the general trade or market them as canned chicken In this way the poultryman lessens his loss besides creating the basis of another industry.

Turkeys

Turkey raising is increasing in the Northwest. Although the mature turkey is a hardy bird, this is not true of the young, which are much less hardy than young chickens The drier climate east of the Cascades is for this reason much more favorable for turkey raising than is that of the damp west coast Moreover, since turkeys are raised for meat production, the industry is concentrated near the feed supply. Meat production is a much less intensive industry than that of egg production Numerous farmers, especially in southern Idaho, the Yakima region, and north-central Oregon have become turkey specialists. The Willamette Valley leads the Northwest in turkey growing Of 2,500,000 turkeys raised in the Region, Oregon accounts for two-thirds. There has been considerable success in the attempt to create a year-around market, and many growers are concentrating upon the production of smaller birds, which will sell at all times The largest sale, however, is to the holiday trade. During November and December carloads of dressed turkey are sent to the markets.

Miscellaneous

Ducks and geese are kept on many farms, especially where water and feed are available The raising of dogs and other pets is both a hobby and source of income Breeders of rabbits and pigeons for sale and food are found mostly among suburban and small-town residents.

Bee Keeping

Although the production of honey does not rank as a major industry in the Northwest, it is of some importance in both coastal and interior sections. In some irrigated areas an interesting phase of the business is connected with fruit culture. Some apple orchardists find it desirable to bring in many bee colonies to aid in pollination of the blossoms during the short flowering season Because the amount of honey gathered will not pay the expense of bringing in the extra colonies, owners of the bees are paid for the trouble Ordinarily, the colonies cannot be kept near the orchards after the blossoming season because

the poison in the sprays would kill the insects Bees are of much benefit as pollenizers of seed crops in parts of Oregon Alfalfa, sweet clover, sage in the deserts, and fireweed on the coast are among the blossoms that provide pasture for bees. The leading honey-producing area is southern Idaho. Other important sections include the Yakima, Malheur, and Willamette valleys.

Fur Farming

There are hundreds of fur farms in the Northwest states and in British Columbia and Alaska, where the cool climate and other conditions are favorable. In Oregon about $450,000 annually in furs is sold by about 230 fox and 175 mink farms The silver fox is the most widely distributed animal raised for its fur in the Northwest Other preferred animals are mink, muskrat, and chinchilla rabbits. The feeding of fur bearers like mink and foxes must be done skillfully to insure a superior pelt, and the animals must be carefully managed to prevent loss from disease. Fish and special fish-scrap feeds available in quantities in the Northwest are much used for fur farms to provide needed elements in the diet. Horse meat is also fed by some growers. In Alaska, off-shore islands are utilized for fur farms on which the animals are raised in semicaptivity.

PART V

INDUSTRY AND COMMERCE

CHAPTER 22

THE TRANSPORTATION PATTERN

R F. Bessey and J C. Rettie[1]

Development of Pacific Northwest Transportation

The first great routes utilized in the exploration and early trade and settlement of the Region during the fore part of the last century were the sea lanes from the eastern seaboard to the Columbia River and Puget Sound Just before the middle of the century an alternative overland route was developed in the famous Oregon Trail, an immigrant wagon road that penetrated the region via the Missouri, Platte, Snake, and Columbia river valleys. In this whole period and until the coming of the railroads the Columbia River played an important role in transportation

The next great advance came with the completion of the transcontinental railroads—the Northern Pacific in 1883, the Union Pacific in 1884, the Great Northern in 1893, and the Chicago, Milwaukee, St. Paul, and Pacific in 1909. These lines with their branches prepared the way for a rapid growth of agriculture, mining, and lumbering throughout the interior.

The opening of the Panama Canal in 1914 was a further boon to Pacific Northwest economic development. It was particularly helpful in opening up both eastern and European markets for lumber, fruit, wheat, wool, and many other bulky products. As a result of competition with the intercoastal steamship lines, there were some reductions in rail freight rates. The availability of refrigerated cargo space also induced the railroads to develop similar facilities for the rapid transport of perishable fruits and vegetables. Port facilities were greatly expanded on Puget Sound and the lower Columbia

New trends are now appearing in the development of lighter, faster railroad equipment and a rebirth of inland traffic on the Columbia River.

During the past twenty years, however, a veritable revolution in

[1] Acknowledgment is made of assistance from James E Maxwell.

transportation has been brought about by the automobile, bus, and motor truck.

The most recent phase of transportation development, also advancing with extreme rapidity, is in the field of airways Within the past decade, there has come into being an extensive system of airports, landing fields, and light and radio beacons, used by regular transcontinental and connecting coastwise and interior lines Statistics of transportation facilities of the Region are given in Table 23.

TABLE 23

TRANSPORTATION FACILITIES OF THE PACIFIC NORTHWEST

1939

	Miles of Line				
	Washington	Oregon	Idaho	Montana	Pacific Northwest
Railroads[1]	5,268	3,406	2,836	5,191	16,701
Highways[2]	6,225	6,981	4,873	6,231	24,310
Inland Waterways[3]					1,098
Airways[4]	725	629	522	1,249	3,125
Pipe Lines[5]				171	171
Total Miles of Line					45,405

[1] Source Interstate Commerce Commission
[2] Source. Public Roads Administration Includes only the total mileage under state control, 1938
[3] Source Corps of Engineers, U S Army Columbia River System only
[4] Source Civil Aeronautics Authority Lighted airways as of June 30, 1940
[5] Source Interstate Commerce Commission Crude oil pipe lines only

The Existing Pattern of Transportation Lines

The transportation system as a whole, providing the channels and reservoirs for the flow of goods, necessarily fits the physical features of the region and the pattern of economic and social development. Its facilities consist of railway, highway, navigation (inland and overseas), airway, and pipe lines, together with their port and terminal facilities.

The general design of the Pacific Northwest transportation system is pictured diagrammatically in Fig 120. This generalized map shows the trunk and strategic lines only. The location of each of the trunk lines, even the air lines, has been strongly influenced by topography—valleys, mountain passes, water grades, plateaus, etc. Conversely the transportation routes have made a strong imprint upon the economic and cultural development of the Region. This interplay of topographic, climatic, economic, and demographic factors can plainly be traced by

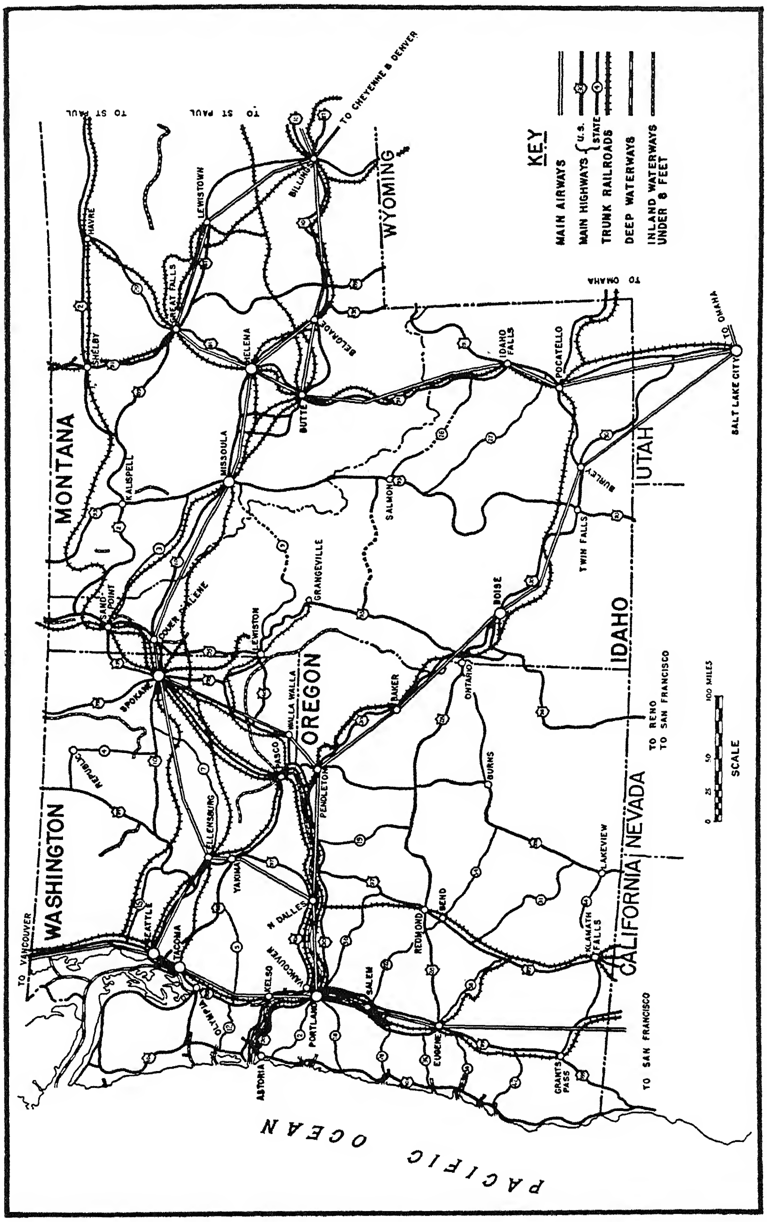

Fig. 120. Major transportation lines.

comparing the pattern of the transportation system with other maps showing relief, land use, population distribution and density, urban areas, and industrial areas. The centering of lines at a port such as Seattle or Portland or at an inland gateway such as Spokane is clearly evident. The funneling of lines of all kinds through the Cascade barrier via the Columbia Gorge may also be noted

The general pattern already set for transportation may be expected to persist, although details will change as new land or mineral or forest resources are utilized. Conversely, the development of new transportation facilities in certain areas will aid in bringing latent resources to the point of commercial utilization.

Present trunk lines generally are adequate for a considerably larger volume of traffic than they now bear. Some new strategic connecting lines and some branch and feeder lines may well be added here and there. The limiting factors lie quite largely in terminal areas—in the cities and metropolitan districts—and material results may be expected from improvements in this field.

Also of special significance in the Pacific Northwest are its transportation gateways to Alaska and the Orient Connections with Alaska through the Northwest are important to the development both of the territory and the region and vital to the national security The renascence of world trade—if and when it may come about—will also add greatly to the significance of these Northwest sea gateways.

Traffic Problems

The foremost problem that confronts all carriers serving the Pacific Northwest, and especially the railroads, is that of insufficient freight for the available facilities As shown by the following figures, the four east-west transcontinental railroads serving the Pacific Northwest operate at a traffic disadvantage. The same general condition prevails in passenger traffic. The deduction to be drawn is that transportation costs will necessarily be high until the traffic density is improved through an increased development of the Region's industries and an increase in its population.

REVENUE FREIGHT MOVED (1936)

	Tons per Mile
Northeast railroads carried	2,000,000
Southern railroads carried	1,700,000
United States average	1,500,000
Northwest railroads carried	1,000,000

Table 24 reveals the general composition of the rail and water traffic

TABLE 24

TRANSPORTATION—VOLUME AND NATURE OF TRAFFIC, PACIFIC NORTHWEST

(Rail and Domestic and Foreign Water Shipments Originating and Terminating in Washington, Oregon, Idaho, and Montana)

	Originating (Tons)	Per Cent	Terminating (Tons)	Per Cent	Total Movement (Tons)	Per Cent	Net Shipments (Tons)	Per Cent	Net Receipts (Tons)	Per Cent
Products of Agriculture	7,446,072	14.2	4,837,348	8.9	12,283,420	11.5	3,305,163	18.2	695,952	5.1
Animals and Products	1,021,872	2.0	1,214,250	2.2	2,236,122	2.1	616,316	3.4	809,444	5.9
Products of Mines	9,045,961	17.3	10,469,120	19.1	19,515,081	18.2	803,118	4.4	2,249,118	16.5
Products of Forests	27,663,137	52.9	16,698,823	30.5	44,361,960	41.4	11,824,981	65.2	860,667	6.3
Manufactures and Miscellaneous	6,813,356	13.0	21,072,415	38.5	27,885,771	26.1	1,592,718	8.8	8,871,758	65.1
Less than Carload	299,979	0.6	452,079	0.8	752,058	0.7			152,100	1.1
Total	52,290,377	100.0	54,744,035	100.0	107,034,412	100.0	18,142,296	100.0	13,639,039	100.0

Sources. *Annual Reports* of Railways to the Utilities Commissions of Washington, Oregon, Idaho, and Montana, U S Department of Commerce, Bureau of Foreign and Domestic Commerce, *Foreign Commerce and Navigation, 1936*, and U S. Army Engineers.

originating and terminating in the states of the Pacific Northwest. It also shows the composition of the total net shipments out of the Region as a whole and the net receipts of goods shipped in from elsewhere The great disparity in the tonnage shipped and the tonnage received is explained by the fact that the Region is shipping great quantities of raw and semifinished products which are heavy and bulky The return flow, on the other hand, is composed very largely of finished manufactures. This condition explains the westward flow of empty freight cars and cargo space on boats which decrease the economic efficiency of both rail and water carriers.

From the standpoint of traffic, the Northwest has a number of characteristics which differ from those of many regions of the United States. Although a few areas—such as the Puget Sound and the Willamette Valley—are quite densely settled, settlement as a whole is sparse and centers of population are generally quite widely separated In relation to population, the Region produces a large tonnage but not a high value of freight On the other hand, its incoming traffic is relatively low in tonnage and high in value. The distances between centers within the Region, the long distance to markets for the Region's production, the relatively low density of traffic and relatively high transportation costs are factors tending to limit development of some facilities and services.

Because the Pacific Northwest must send a large proportion of its production to distant markets and, at the same time, obtain from distant regions the bulk of the manufactured products which it consumes, the problem of freight rates is particularly important.

Railways

Principal lines in the Pacific Northwest include four east and west transcontinental main lines (Great Northern; Chicago, Milwaukee, St. Paul, and Pacific, Northern Pacific, and Union Pacific railways), a major north and south intracoastal line (Southern Pacific and joint services northward), and several important connecting trunks, like the Spokane, Portland and Seattle Railway These lines are shown in Fig. 120; in addition there are numerous branch lines not shown.

The fifty-year era of railroad expansion in the west reached its maximum mileage before 1920, there has been little change in railroad trackage in the Pacific Northwest since that time. Few, if any, new lines are in prospect, although several projects have been considered from time to time. It should be noted, however, that there is a general

tendency toward the abandonment of minor railway branch lines and toward service of their areas by highway features.

On the railroad system generally the density of traffic is lower and the rates are higher than in most regions of the country. Each mile of line serves less than half the number of persons served by the lines of the country as a whole. In a number of sections there is uneconomic paralleling of lines and duplication of facilities and services

Among the possible changes affecting existing lines in the Northwest are.

(1) Consolidations

(2) Joint services among railroads, and between railroads and highway or water lines

(3) Improved fast freight services between cities, including pick up and delivery services

(4) Extension of fast passenger services to meet air and automobile competition

(5) Lightening of equipment

(6) Extension of electrification of lines.

Highways

The highways of major importance—the trunk and strategic lines—are shown by Fig 120 Beyond these principal routes there is a great net of primary and secondary lines closely covering all the developed areas, and more thinly covering the forest, mining, recreational, and wilderness areas

Road building during the past generation has passed through an era of rapid expansion to meet the conditions imposed by the growth and shifts of population and the development of motor vehicles. The present network of automobile highways is nearing completion. Although some new links may still be required in the primary system, emphasis is shifting to improvement of routes, gradients, curvature, widths and pavements, and to rights of way and control in the interest of a better-directed flow of traffic, to greater safety, and to greater roadside beauty.

A basis for objectively determining conditions and needs in highway transportation is provided by the comprehensive highway-planning surveys carried out by the states with federal co-operation during recent years. These surveys make it possible to relate road locations, plans, and construction much more closely with present and prospective patterns of population, land use, and traffic. Through maps, charts and other data now available, improvements in primary routes may be

made more closely to meet requirements of present and potential traffic density, and secondary routes can be laid out better to serve community, agricultural, forest, and mineral activities and to meet shifts in land use, population, or industry.

Inland Waterways

Inland waterways, navigable for shallow draft equipment, extend far inland in the Columbia River system. Present river improvements in the Columbia, together with the Bonneville dam and navigation lock, will extend facilities for ocean shipping to The Dalles, 188 miles inland. Other similar waterways extend short distances inland from some of the other harbor areas In addition, there are local inland waterways in such lakes as Pend Oreille, Coeur d'Alene, Flathead, and Chelan. Very shortly another navigable waterway will be available in the Grand Coulee pool extending 150 miles from the dam to the Canadian border.

The Columbia River trunk waterways, considered navigable to Lewiston, Idaho, 470 miles from the sea on the Snake, to Priest Rapids on the Columbia in central Washington, and to Albany on the Willamette in Oregon, are gradually undergoing improvement which will greatly increase their effectiveness as arteries of commerce. It is also possible that this inland system may ultimately be connected with Puget Sound by an intracoastal canal extending through Willapa Bay and Grays Harbor.

In recent years, largely as a result of the completion of the Bonneville lock and open river improvements below the mouth of the Snake, inland traffic on the Columbia has shown a sharp upward trend Principal downstream movement is at present in agricultural and forest products whereas major upstream commodities are petroleum products. Co-ordination of navigation and port improvements with traffic growth should make it possible for the Columbia waterway system to reoccupy its former important place in the scheme of development and service of the Region. Improved channels, ultimately including slack water canalization in more difficult river reaches together with improved operation equipment and terminal installations, should become an increasingly important factor in utilization of latent resources and in the establishment of suitable heavy industries in the Columbia Basin. The development of the now almost vacant Columbia Basin area under the Grand Coulee project in central Washington and the development of navigation in the Columbia and lower Snake should have mutually stimulating effects.

Airways

The generalized transportation map, Fig. 120, shows only the main trunk airways. The present airways system includes many other airports, landing fields, aids to air navigation, and local and special services. Present and future links to Alaskan and Canadian airways—including the newly inaugurated "clipper" line from Seattle to Alaska—are an important feature of Northwest airways

In a region of great distances like the Pacific Northwest, air transportation assumes more than usual importance The civil airways facilities—and with them air traffic—have grown rapidly during recent years. An outstanding problem of their development is the establishment of a more complete and unified system of airports, landing fields, and air navigation aids. Difficulty is added to this problem by the need of harmonizing this system with the needs of military aviation and national defense and at the same time with requirements of civil aeronautics, including accessibility of service to the larger centers of population and transportation Highway services are especially essential to the operation, maintenance, and supply of air lines and their ground facilities, and there should be a close correlation of highway, airport, and secondary and emergency landing field locations.

Pipe Lines

This means of transportation, very important in some sections of the country for moving oil and gas, has had, thus far, only limited application in the Pacific Northwest There are a few local gas or petroleum lines in Washington, Oregon, and Idaho and a number in Montana. The most important trunk system is one transporting natural gas in central Montana There is also a current proposal for a crude-oil pipe line from Montana oil fields to the Spokane area.

Ports and Terminals

Port and terminal facilities—performing the essential functions of shipment, receipt, interchange and storage—are as vital in the transportation system as the lines and operating equipment and the movement of goods from one place to another. The greater part of labor, time, and expense involved in transportation is consumed at terminals. Hence the greater opportunities for improvement in service and efficiency and reduction of cost quite generally lie in the design or operation of one kind or another of terminal facilities.

Public-port terminals provide not only for the loading and unloading of vessels, but for the interchange between various carriers, storage, and

other related functions. Only a few terminals in the Northwest also provide space and services for the processing, milling, or manufacture of goods at the interchange point.

Railroad terminals in the Pacific Northwest illustrate competitive duplication of facilities in a considerable number of instances although some unification of both freight and passenger facilities has been worked out in a few cities. In the field of highway transportation, there has been, for example, some unification of freight and passenger depots that serve a number of carriers. In the case of air transportation, most cities have a single airport for all lines. The major problems of ports and terminals lie largely in unification and improvement of services.

CHAPTER 23

MANUFACTURING IN THE PACIFIC NORTHWEST

By Alfred L. Lomax

Manufacturing is one phase of man's productive use of the environment Just as agriculture is concerned with extracting a livelihood from the soil, so manufacturing involves the alteration of the form of raw and semiprocessed materials at convenient points preparatory to consumption. Viewed from the economist's standpoint, manufacturing involves the creation of form utilities rather than time (warehousing) and place (transportation) utilities The emphasis must therefore be on the regional production of goods rather than on the distribution to consumers.

The factors which are essential for the establishment of a manufacturing economy are the amount and availability of raw materials, the accessibility of power and fuel, water for industrial uses, capital, a "pool" of skilled and unskilled workers, the facilities of transportation, and a market Man (labor) is at work (production) at machines (capital) in specified areas (location) using commodities (materials) which will be shipped (transportation) to markets (consuming areas) either for direct consumption by persons (workers) or by factories (manufacturing) to be further processed.

Raw Materials

The principal raw materials, or primary resources for manufacturing, in the Pacific Northwest are logs, grain, fruits and vegetables, livestock, fibers (both animal and vegetable), minerals, and fish Various aspects of their production have been treated elsewhere in this book.

Most of the processing and manufacturing occur in the Willamette-Puget Trough, a region which has built its economy very largely upon timber and agricultural resources. From pioneer times to the present, processing industries, such as sawmills, flour mills, and fish canneries, have been important More advanced manufacturing is gradually overtaking the simpler processing Forest products go into a variety of articles from paper to high-grade furniture; specialty foods have be-

come more numerous; chemical and electrometallurgical establishments are availing themselves either of cheap power, market proximity, or raw materials; and various branches of clothing manufacturing have become a permanent part of our economy.

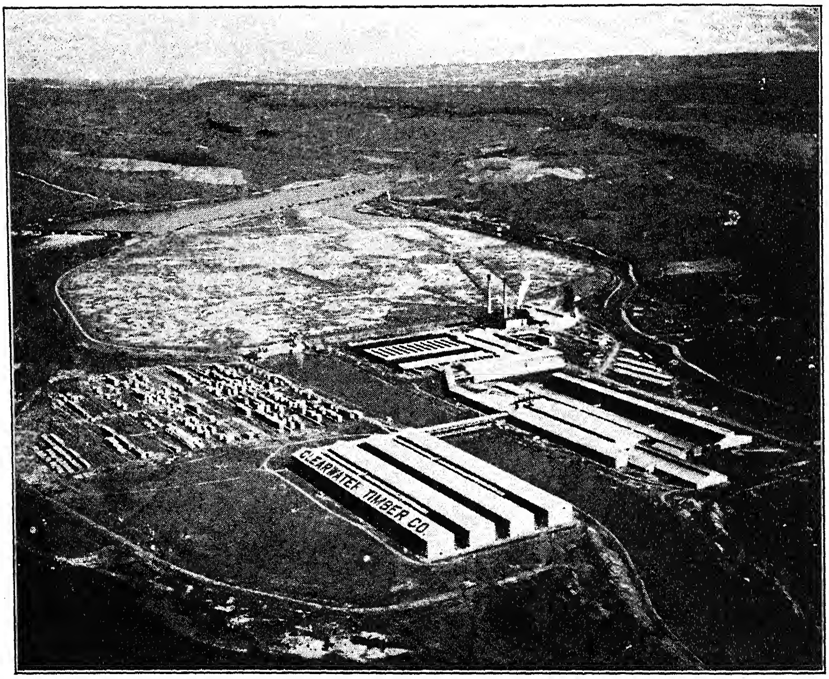

FIG. 121. The largest white-pine sawmill in the Northwest, at Lewiston, Idaho.

The area east of the Cascade Mountains, on the other hand, is still dominantly a "processing" one, with forests, farms, and mines contributing to the pine mills, canneries, sugar-beet factories, and smelters.

Labor

A large proportion of the population in this part of the United States is engaged in working the forest resources into furniture, paper, veneer, and other articles. Approximately 87 per cent of these workers are in western Oregon and Washington. Sixty-two per cent of all factory workers in the Northwest are in the forest industries. This labor supply has been augmented within the past decade by approximately 400,000 people. Most of them are in agriculture, but many craftsmen, technicians, and supervisors are also included.

Power and Fuel

The Pacific Northwest is synonymous with hydroelectric power, the three states comprising this region having 41.4 per cent of the potential hydroenergy of the nation.[1] Of this amount adequate power has been developed and electricity is available to municipalities, electrochemical industries, and other consumers at extremely low rates. The Federal Power Commission states that 96 per cent of the total power produced in this zone is water power.

As an economic factor, however, it is sometimes overemphasized, for it is only one of many factors which comprise the total cost of manufacturing.

In contrast to the abundance of water power, there is a paucity of high-grade fuel. Whereas Oregon has no coal beds of industrial importance, Washington and British Columbia have extensive deposits. Hogged fuel is used considerably in western Oregon and Washington owing to the large number of sawmills and to the cheapness of this fuel. California fuel oil is delivered by regular tanker service to Northwest ports, and from these points is distributed by truck, barge, and rail to inland points.

Capital

The regional aspects of capital engaged in manufacturing (which includes capital goods such as machinery, tools, and accessories as well as money capital and credit) must be considered in a geographic sense. Capital, like labor, must be available for use. Local residents were at one time the principal investors in the small lumber, flour, and woolen mills. Later capitalists entered the Region and financed large sawmills and other undertakings. Today the Northwest has a certain amount of capital for industrial investment. However, the reservoirs of local capital and credit are not large enough to finance many of the new factories which have recently located within the Pacific Northwest; consequently they draw upon the resources of New York, Pittsburgh, and Detroit. Frequently these investments take the form of branches like the recently established aluminum plant at Vancouver, Washington.

The repercussions of such influxes of capital have far-reaching effects upon the economic life of the Northwest. The immediate results are augmented payrolls, savings from workers' wages and administrative salaries, purchases of supplies and equipment from complementary[2] in-

[1] Federal Power Commission, Interim Report, 1935.

[2] Those which serve other industries, e.g., machine tool makers, manufacturers of logging equipment, tin cans, etc.

dustries, and a noticeable increase in demand for consumers' goods from local industries.

As population increases, more service[3] industries are established, financed by both local and outside capital. Fabricating and assembly[4] plants likewise follow population movements. Such developments indicate the trend toward industrialization of the Northwest Within the Region this has centered in Portland's environs, the adjacent Willamette Valley, the Puget Sound area, and to some extent in the territory lying between the Cascades and the Rocky Mountains. In some of this eastern section, the establishment of processing industries such as canneries and beet factories has been more phenomenal than in the western section, but with a minimum of other kinds of manufacturing.

Markets and Transportation

Although natural resources and power have been instrumental in attracting manufacturing plants to the Pacific Northwest, transportation costs from eastern factories and proximity to consumer's markets have also been favorable factors These conditions have caused the building of many new plants in the Willamette Valley and Puget Sound areas Frequently these plants become so successful that they have some distribution outside the local area Examples are the recent aluminum plant at Vancouver, Washington, the chemical works at Tacoma and Portland, and the Seattle airplane industry.

The markets reached by the Northwest are classified as the local, which covers the entire Pacific Northwest area and Alaska, the immediate domestic, i e, the Pacific Coast and Rocky Mountain states, the national, and the export to foreign countries and insular territories.

Transportation, whether by rail, water, or highway, is the medium by which raw materials, fuel, and supplies are brought to the factory, and finished goods taken to market. It is part of the total cost and thus vitally affects the location of manufacturing plants. A milestone in the industrialization of the Region was the opening of the Panama Canal in 1914, which vitalized the commerce and industry of the entire Pacific Coast by creating a cheap water route to Atlantic ports It became possible to ship boatloads of flour, lumber, wool, apples, pears, and salmon

[3] Light and power companies and publishing companies usually serve a local area as compared to manufacturing industries, which usually have large domestic and foreign markets

[4] Steel beams and parts shipped in separately are riveted together near the local market Fenders, chassis, rims, etc, are assembled at strategic market centers like Portland and Seattle

to these markets. Return cargoes consisted of semiprocessed and completely manufactured goods of all kinds Rail freight rates because of this water competition have, in general, been reduced, thus making the region west of the Rocky Mountains more attractive to eastern industrialists

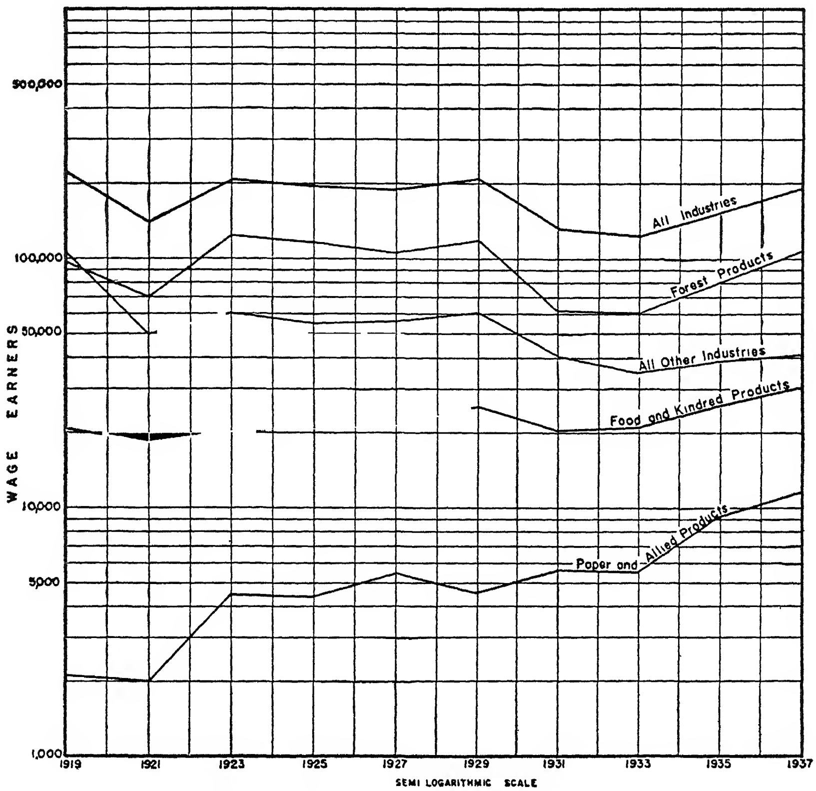

FIG 122 Average number of wage-earners employed in manufacturing industries. (*Pacific Northwest Regional Planning Commission*)

Study of the table showing value added by manufacture (Table 25) indicates that the forest products of the Pacific Northwest in relation to those of the nation add the greatest value by manufacturing in that classification, or 24 per cent, and, insofar as the comparison is made with Pacific Northwest industries alone, forest products are credited with 48 per cent or nearly half the value added by manufacturing for the entire Region It will be observed from the figures in column 5 that approximately 60 per cent of the value added by manufacture in

TABLE 25

VALUE ADDED BY MANUFACTURE IN THOUSANDS OF DOLLARS

(From *Columbia Basin Report*, Pacific Northwest Regional Planning Commission)

Industry	1 U S	2 P N W	3 % of U S Total 2/1	4 % of All Industries U S 1/1	5 % of All Industries P N W 2/2
All Industries	31,885,284	679,423	2 13	100 00	100 00
Processing					
Agriculture	1,318,618	55,411	4 2	4 14	8 16
Forest products	1,359,949	326,348	24 0	4 27	48 03
Water resources	198,753	7,409	3 7	0 62	1 09
Minerals *	1,496,216	14,189	1 0	4 69	2 09
Subtotal	4,373,536	403,357	9 2	13 72	59 37
Manufacturing					
Agriculture	1,962,151	31,666	1 6	6 15	4 66
Forest products	1,262,268	30,086	2 4	3 96	4 43
Minerals	7,614,543	66,593	0 9	23 88	9 80
Clothing	2,068,810	11,579	0 6	6 49	1 70
Foodstuff (N E.C)	419,313	7,362	1 8	1 32	1 08
Printing, publishing, etc.	2,381,579	43,748	1 8	7 47	6 44
Sporting goods, etc.	944,615	790	0 1	2 96	0 12
Luxuries—Jewelry Not elsewhere classified	10,858,469	84,242	0 8	34 06	12 40
Subtotal	27,511,748	276,066	1 0	86 28	40.63
Total	31,885,284	679,423	2 13	100 00	100 00

* Does not include smelting of metals, which is not given separately in four Northwest states

the Region lies within the processing group of industries, whereas only 40 per cent is credited to the manufacturing group. This again is simply another way of saying that the Pacific Northwest devotes a very large portion of its manufacturing efforts to the utilization of the extractive commodities, with forest products dominating the economic scene.

Woolen Textiles

Commercial woolen manufacture in the Northwest dates back to 1857, when the first textile mill west of the Mississippi was built at Salem. Wool from local flocks was plentiful in the Willamette Valley, and home spinning and weaving were common on farms. Influenced by cheap and abundant raw material, the excellence of the local water supply both for power and for washing fleeces, and the high price of imported woolen cloth, Oregon pioneers decided to found a new in-

dustry. For a market they counted on the growing Northwest settlements and also the California gold fields, where there was a steady demand for coarse but durable clothing material.

The ambitious farmer-industrialists who organized the early mills had their difficulties. Capital was scarce in the newly settled region and interest rates were high, often as much as 1 per cent per month. Carding machines and looms, ordered in Massachusetts, had to be brought around Cape Horn to San Francisco, reloaded for Portland, thence transshipped inland by small river boats. Citizens of near-by towns and countryside were given employment, augmented later by spinners and weavers from the East. Experienced mill executives were unknown

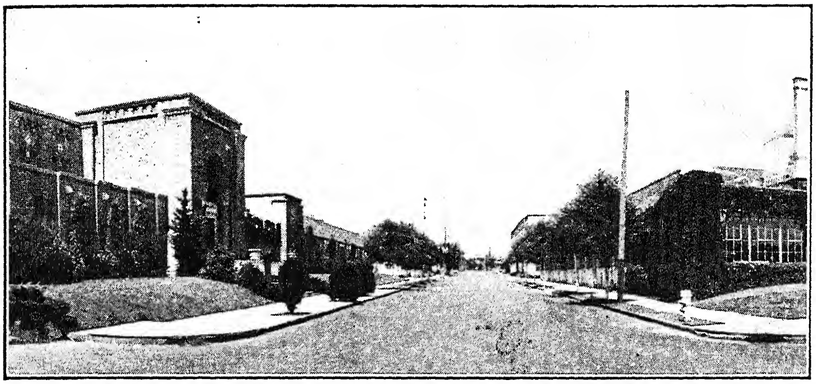

FIG. 123. Modern wool knitting plant in suburbs of Portland.

in the West, so English and Scotch superintendents from Philadelphia factories came out by way of Panama. Descendants of these early superintendents today operate mills of their own in Oregon.

By 1866 five more mills were in operation—at Oregon City, Brownsville, and Ellendale in the Willamette Valley, Ashland in the Rogue River Valley, and The Dalles on the Columbia River. The anticipated markets developed, cloth imported from the East remained high in price, the quality of local woolens improved steadily, and the industry prospered for a time.

In the modern expansion of this industry there have been certain changes of location, but the Willamette Valley and Portland, including Washougal, is the principal area of concentration. Valley mills are located as far south as Eugene; there is also one at Pendleton in eastern Oregon, and another at Eureka, California, which belongs to this general Northwest grouping. The industry is controlled by local capitalists.

Most of the raw wool comes from the western and Rocky Mountain states through Portland, which is the nation's largest primary wool market. Although the larger share of the wool sold at the annual wool auction in Portland is purchased for intercoastal shipment to Boston, Oregon mills buy a considerable portion of the clip.

With an early start and many decades of experience in wool manufacturing, Northwest mills produce fabrics which compare favorably with those of the East This also applies to fastness of color made possible by the nonalkaline water of the region. The principal output is in knit goods, suitings, and blankets[5] which have both a national and a local distribution. Some mills also have their own departments which style men's wear for sale locally.

Clothing

This broad term includes several subdivisions of the industry such as sportswear (ski togs, outing shirts, jackets), knit goods (swimming suits, sweaters), work clothing (overalls, jackets), and women's dresses.

Portland and Seattle lead in the manufacture of clothing in the Northwest. The local demand from loggers, fishermen, farmers, city dwellers, and others was an important factor for starting the industry. Favorable factors for the continuance of clothing manufacture in the two cities include their importance as retail market centers, favorable location for wholesale distribution, the early start made by the industry, and good management. Some factories, locally financed, have expanded into concerns with national and international reputations. Consistent national advertising has made the buying public trademark conscious, particularly in the sportswear and swimming-suit field. The nation-wide tendency to use the summer recreational facilities of the national parks and beaches of the Northwest, together with the rapid development of winter sports in the same area, has definitely stimulated the production of all kinds of outdoor wear. Workmen's clothing, such as overalls, lumber jackets, and "tin" pants for use in the woods and elsewhere, is sold mostly in the Pacific coast and Rocky Mountain states. There are seven plants in Washington and two well-known manufacturers in Portland Men's and boys' clothing is made in twenty establishments The manufacture of women's wear has become increasingly important in the Pacific Northwest, centering in Portland and Seattle. There are no less than twenty such plants in Oregon and thirty-nine in Washington. Interestingly enough there are no clothing factories in Idaho.

[5] Includes blankets sold to traders on the Indian reservations

Flax and Linen Products

The Pacific Northwest has optimum conditions for the production of fiber flax a damp spring growing season, dry summer harvest period, and pure water for retting These conditions are similar to those of the Courtrai district of Belgium which is reputed to grow the finest flax in the world The Oregon flax resembles the Belgian product in strength, but is coarser.

Unlike most manufacturing industries, certain agricultural phases are traditionally associated with the initial processing, that of retting (or rotting), which involves soaking the pulled flax in cratelike containers under water for several days. The wet bundles are then withdrawn and allowed to dry in the sun, after which they are taken to the scutching mill and passed through rollers which break the tough, woody portion of the stem free from the valuable fiber.

The Willamette Valley is the most important flax-growing and manufacturing area in the Pacific Northwest with retting and scutching plants located in Springfield, Mount Angel, and Canby. These plants have been established on a co-operative basis by flax growers with the help of the state of Oregon. The semifinished fiber is sold to mills through the Oregon State Flax Control Board The state penitentiary at Salem also operates a flax plant.

Before the fiber is actually manufactured, it is boiled (with the exception of that which is selected for sack twine) to remove the gummy substance which adheres after retting It is previously hackled, that is, combed out to remove the woody portion and the short fibers The long superior fibers are then manufactured into sack yarn, shoemakers' thread, and fish-net twine The short ones were at one time used for weaving linen crash goods, but are now sold to upholsterers.

Oregon's two privately owned linen mills are located at Salem, where only twines are made. Although one of the mills makes gill nets from its own yarn, in general the manufacturers depend upon imported European flax fiber that is mixed with the Oregon product

One of the principal problems of the industry is the difficulty of attracting private investors, although eastern capital has become interested in Oregon flax manufacture Another problem lies within the field of marketing, it is the constant impact of competitive and substitute commodities, like cotton, which tends to limit the use of linen twines and forces the price downward. Shoe manufacturers are substituting cotton thread, although the opposite is true of fish-net twine, which has been and still is dependent upon linen.

Pulp and Paper[6]

Paper is made by the felting of cellulose fibers in a thin sheet Certain trees have a high cellulose content, hence their desirability as raw material in the manufacture of pulp The industry requires ownership of or access to very large timber supplies, a large and constant flow of pure water, and cheap power The mills are classified according to the kinds of pulp they manufacture. There is the groundwood or mechanical mill, which macerates wood blocks between giant stone grinders with very little chemical treatment afterward It is a weak pulp The chemical branch is subdivided into sulphite, sulphate, and soda in which the processes involve treatment of chipped wood by various chemicals to produce a strong pulp.

Raw Materials and Mill Location. The history of the industry in the United States has been one of constant shifting from one raw material area to another, and the Pacific Northwest is now one of the leading pulp and paper regions Southwestern Washington, the Olympic Peninsula, Puget Sound and British Columbia, Northwestern Oregon, and the western slopes of the Cascade Mountains in both states comprise an area approximately half the size of the state of Washington These 45,000 square miles, containing several hundred million cords of suitable pulpwood, have:

12 chemical pulp mills	1 sulphite and kraft mill
11 sulphite mills	3 kraft mills
2 sulphate mills	2 soda mills
3 newsprint mills	3 board mills

They produce over 4,500 tons of pulp daily, or an equivalent of 2,750 tons of paper.

The principal species used in pulp making are western hemlock, Sitka spruce, balsam fir, Douglas fir, and black cottonwood Hemlock and balsam fir are a relatively cheap source as these species are so-called logging by-products (left standing or on the ground after the Douglas fir has been removed) and would be completely wasted were it not for the pulp mills. In contrast, Douglas fir is not yet extensively used, although relatively small quantities are employed in the sulphate and soda mills.

The Northwest is the most important producer of sulphite pulp in the United States, 11 of the 15 plants being located in this part of the nation. It is used in newsprint, high-grade papers, rayon, and other

[6] *The Pulp and Paper Industry of the Pacific Northwest,* published by the Corps of Engineers of the United States Army, the North Pacific Division, Portland, Oregon, June 1, 1937, was extensively used in the preparation of this paper

cellulose products. Sulphate or kraft pulp goes into the heavier papers and paper products, whereas the soda plants produce fillers for high-grade book and writing papers.

The four newsprint plants in Oregon and Washington and the two in British Columbia are either in the heart of, or in proximity to, great pulpwood supplies. Those in the Willamette Valley haul their logs by rail from the Oregon Coast British Columbia specializes in newsprint, but Oregon and Washington are diversified, producing everything from newsprint to book paper.

Power and Fuel Of the different kinds of pulp and paper mills, the groundwood or mechanical is the largest user of power. It is the most important single consumer of electric power in the Columbia River area. In the manufacture of newsprint, the giant Fourdrinier machines, 200 to 300 feet long, making paper at the rate of 1,200 feet per minute, require constant and cheap power The mills obtain this either through purchase from a central station or by generating it in their own plants. The latter is possible either by utilizing a near-by stream (hydroelectricity) or burning hogged fuel or fuel oil to operate steam generators.

Markets. The Pacific Coast and Rocky Mountain states are the principal paper markets, California taking 50 per cent of the output Paper exports are unimportant and freight rates to the East almost prohibit competition in that market.

Bleached sulphite pulp, on the contrary, is shipped to the East, the Southwest, and to foreign markets, particularly Japan, where it is used in rayon and other cellulose manufactures. Transportation rates are a vital factor in determining the competitive position of the Northwest pulp and paper industry All forms of transportation except airplanes are used to reach the domestic market. Advancements in pulp and paper chemistry are developing new uses.

Printing and Publishing

These industries, unlike some of those previously discussed, have no distinctive geographic or economic elements to make them stand apart as typical of the Pacific Northwest. They are found in every civilized community all over the world. They are primarily service industries catering directly to consumers' needs. Design, assembly, and strict adherence to ancient traditions of the printing craft are characteristic. Fiction and general book-publishing houses, technical and medical book publishers, textbooks, children's books, periodicals, and newspapers comprise the subdivisions. Mention should be made of presses

which issue nothing but very special editions, often hand printed, such as the John Henry Nash Press now at the University of Oregon. There are several hundred newspaper, printing and publishing, book and job printers in the Pacific Northwest. This area has the reputation of being an excellent book market owing to the high percentage of literacy and the perpetuation of broad cultural activities. The past decade has witnessed a marked demand for the history, wildlife, and biography of the region, which has stimulated the establishment of presses specializing in the printing of such books. The principal cities like Portland and Seattle are leading publishing centers, with the modest-sized city of Caldwell, Idaho, an interesting addition to the list.

Ship and Boat Building

Because of its natural activities—lumber carrying, fishing, the Alaska trade, pleasure boating, etc.—the coastal margin of the Pacific Northwest has long been a steady consuming market for vessels of every size and design. As a result, ship-building and boat-building yards multiplied and are found everywhere along the coast. Here skilled craftsmen turn out fishing boats of every type, scows and barges, tugs and towboats, and hundreds of pleasure craft, both sail and power driven. Most of them are built to order for individual customers. Even the smaller river communities support small boat construction.

Although the Northwest has no great steel centers like the Atlantic coast, the larger yards of the Region in cities like Seattle, Tacoma, and Portland are launching a number of steel vessels for the merchant marine. Puget Sound yards made a number of ship-building records during the First World War, and Washington still leads Oregon in ship building. The two states have sixty-six yards constructing both steel and wood boats, and, with Idaho, contribute materials not only to the local yards, but to the nation at large. Douglas fir, cedar, spruce, lead, silver, zinc, cement, veneers, wire rope, and machinery are furnished the local yards. Obviously, the steel and iron materials must be shipped in by rail or boat.

Recent national defense plans, as in the First World War days, have stimulated ship building in this section of the United States. The Puget Sound Navy Yard in Bremerton, one of the great ship-building centers of the United States, is employed only on naval construction.

Airplanes

The manufacture of airplanes in the Pacific Northwest centers in Seattle, where over 10,000 workmen and engineers are employed. Dur-

ing the first years of its development, the factory used local spruce as its basic material, but, as technological improvements made themselves felt, metal displaced entirely the weaker wood material. The fuselage and wings of a modern plane are now constructed of an aluminum alloy, and the importance of airplanes on the Pacific coast was a

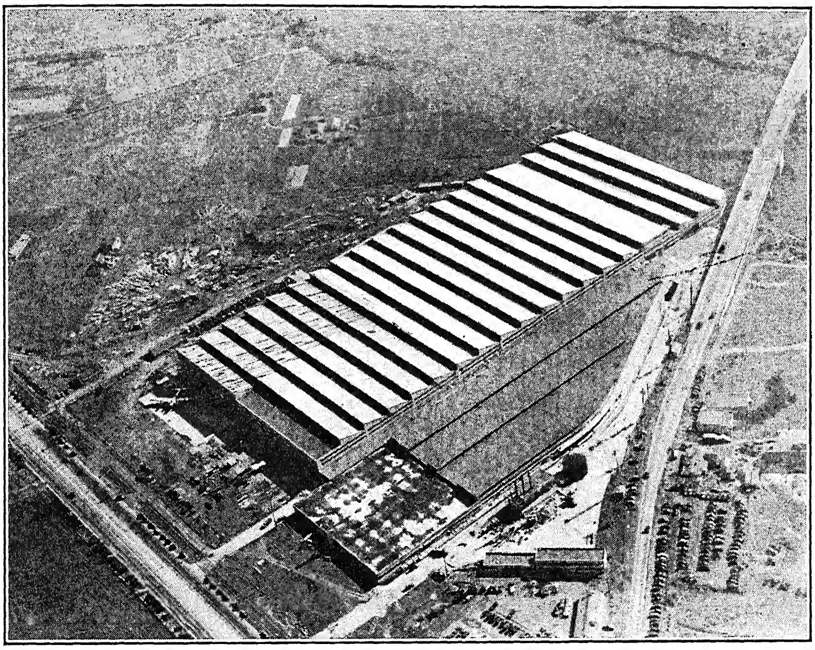

FIG. 124. Airplane factory in Seattle. (Courtesy of *Boeing Aircraft Co.*)

factor in building new aluminum plants. The market is principally for government bomber planes, although large passenger planes operating over transcontinental and trans-Pacific routes have been built by the Seattle factory.

Furniture

The Pacific Northwest is becoming nationally known as a furniture-manufacturing area. The vast stands of Douglas fir in which grow also the hardwoods—alder, maple, oak, cottonwood, ash, and birch—insure ample supplies of raw material. Of these woods the alder is the most important, and is especially important for core stock in the plywood used in furniture making. Walnut from the Central states, Philippine mahogany (not a true mahogany), and various hardwoods from South

and Central America are imported for veneers and panels. Most of the furniture manufactured in the Region is marketed in the Pacific coast and Rocky Mountain states, although some shipments are made to other parts of the country, including Hawaii. Portland boasts the two largest furniture-manufacturing plants on the Pacific coast which pro-

FIG. 125. Auction sale of wool in Portland. (*Commission of Public Docks, Portland.*)

duce one-third of the volume in this area. Oregon is the thirteenth state in production of furniture. Tacoma leads in Washington. Proximity to an abundance of raw materials, the skilled workmen, a facile transportation service, and the reputation of the manufacturers are factors favoring this industry.

Miscellaneous

The census in 1937 lists 5,697 plants in the Northwest (Washington 3,057, Oregon 2,107, Idaho 533), a decline in numbers of 1,000 since 1929, which resulted mainly from consolidation and abandonment of small or unprofitable operations. The census enumerates over one hundred manufacturing industries that are carried on in the Northwest. In addition, hundreds of minor examples are included under "all others." Some of the more important are:

- Awnings, tents, sails.
- Beverages
- Bookbinding
- Bread and bakery products.
- Car and general repairing
- Clay products, not pottery
- Coffee and spices
- Concrete products
- Confectionery.
- Copper, tin, sheet iron.
- Foundry and machine shops
- Ice cream
- Manufactured ice
- Jewelry
- Motor vehicles, bodies, parts
- Paints and varnishes
- Patent and proprietary medicines.
- Signs and novelties
- Stoves and ranges, not electric.

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CHAPTER 24

PACIFIC NORTHWEST INDUSTRIAL POTENTIALITIES

By Ivan Bloch

In attempting to chart the future pattern of Pacific Northwest industrial development it is desirable to review briefly the essential factors which lead to the establishment and location of industrial plants

These factors are controlled by the basic concept underlying any industrial operation the profitable production of salable goods, whether these goods be toothbrushes, steam shovels, or bags of cement. In other words, industry is established so as to produce goods for which there is a demand and which can be sold for a reasonable price, providing for reasonable profit to the plant owner.

This basic concept therefore imposes on industrial activities many restrictions, which can be classified as "industrial plant selection factors." These factors when analyzed provide a balance sheet, the total of which is a guide for action, for the prospective industrialist and investor. In the brief discussion which follows the relative importance of the factors is not necessarily in the order given, or with the emphasis placed upon each.

In the consideration of each factor, with the exception of those relating to markets, the industrialist will, of course, ascertain quantity, quality, and costs.

INDUSTRIAL PLANT-SITE FACTORS

1. *Raw and Semiprocessed Materials.* This factor is concerned with the materials from which the salable goods will be produced. For example, an industry which needs large quantities of wood will not locate in the midst of the desert, but near large forests, the first large iron and steel industries of this nation were located in Pennsylvania, because iron ore and carbon were readily available within reach of the furnaces.

The industrialist will investigate the location of the material he must use, and he will ascertain whether this material is of the quality which his processes require and whether the material is readily ob-

tainable and available in sufficient quantities over a period of years. He will survey carefully the costs of extraction, transportation, and initial beneficiation. In many instances, the industrialist must investigate the technology required for the processing of the material, should it require special treatment. There, again, his costs will be carefully estimated.

2. *Fuel and Power.* This factor deals with the availability and cost of fuel or power for heat, or for the operation of machinery, or for the actual chemical and physical conversion of the raw materials into usable goods. That is why in early Colonial manufacturing days, industries selected sites near rivers that would turn the water wheels of the plants. Obviously, the requirements of each industry for fuel and power are different. In some instances electric power is an extremely important item; in others, steam is essential. In every instance, however, the supplies must be sufficiently continuous and dependable to provide for steady operation year after year and at reasonable cost.

3. *Labor.* This factor is one not always considered important owing to the relative mobility of labor. In recent years, however, the industrialist has been inclined to investigate closely the amount, type, and cost of labor available in a locality for the handling of material and machinery in manufacturing processes There, again, the requirements vary with the industry, the skills involved ranging from high expert rolling-mill handlers to relatively unskilled ordinary labor.

In many instances freedom from labor disturbances is an item of high importance to the prospective industrialist

4. *Transportation.* Facilities and costs for the transportation of raw materials from the forests or the mine or the primary industrial plant to the manufacturing plant, as well as those required to carry manufactured products to markets, govern one of the most important factors considered by industry. This is particularly true in regions of the United States somewhat removed from large centers of population When a bulk product is manufactured involving large quantities of raw materials, industry will select a site carefully, all other factors being equal, near the most inexpensive and most reliable transportation facilities In some instances the plant will locate as near the source of raw materials as possible, in others, it will locate on tidewater sites so as to take advantage of water transportation. In all cases, items of reliability and costs of transportation are carefully weighed.

5 *Markets.* Obviously, no industry can survive unless it can sell its product at a price and in quantities that will result in a reasonable profit. Consequently, an industry is particularly interested in deter-

mining the areal zones within which its products can be sold competitively with similar products at prices that consumers will accept All other factors being equal, costs of transportation and size of the market are controlling items of extreme importance. For example, a product made a long distance from large markets may overcome the disadvantage of distance if the margin between costs and sales price is sufficiently large to absorb transportation costs.

The determination of markets for a product is indeed a complicated procedure in which the economist and the statistician contribute much. A multitude of items must be considered, including trends in population, the purchasing habits of consumers, and the stability of their purchasing power. Factors related to competitive grade, governmental regulations, technical advantages, and the like should be carefully analyzed.

Recapitulating, it may be said that the industrialist selects a specific location for his operations if his balance sheet of plant-site factors is favorable in the items of (1) raw materials, (2) fuel and power, (3) labor, (4) transportation, and (5) markets As pointed out, all items involve analyses on the bases of quality, quantity, costs, and competitive situations.

This pattern of selection when applied broadly to the Pacific Northwest is likely to furnish the clue to future and potential industrial development of the region, although, to be sure, there are uncertainties and unknowns which may affect any tentative conclusion

PACIFIC NORTHWEST PLANT-SELECTION FACTORS

Limitations in the Present Regional Structure. A rough overall balance sheet can be drawn up for the Region embracing the states of Washington, Oregon, Idaho and Montana. However, there are certain broad aspects of the present economic structure of the Northwest which tend to restrict the initial scope and character of potential industrial developments. It should be pointed out that these restrictions will no doubt be subject to change with the passage of time Briefly stated in the order of their consecutive importance, these broad aspects are.

(*a*) The preponderance of agricultural and forest-products industries and the striking lack of manufacturing in the economy of the Region

(*b*) The comparative low density of population in the Region, which, however, is changing by a steady increase of population, due principally to migration from other parts of the nation

(*c*) The long distance of the Region from the heavily populated centers of the Middle West and the East.

(*d*) The relative infancy of the Region which is reflected in a lack of detailed commercial information on its resources, particularly those of a mineral base

1. *Raw Materials*. In terms of raw materials, with the notable exception of agricultural and forest products, the balance sheet of the Region contains many gaps. Industry seeking raw materials for the establishment of a plant in the Northwest often has difficulty in obtaining accurate information as to quality, quantity, location, and costs of such resources. This is particularly true of mineral resources This lack of knowledge has been due principally to two conditions. (*a*) Although careful investigations have been made of Northwest minerals, they have been principally in the field of precious metals Only recently has interest developed in metals and nonmetals of other classifications (*b*) The ruggedness of the terrain, its inaccessibility, and the density of vegetation have made geological and mineral surveys difficult

With the growing interest of industrialists and the new emphasis placed by the government on strategic and critical minerals important to our national defense, the Northwest storehouse of mineral raw materials is slowly being charted so that the prospective manufacturer can obtain more readily the information he seeks Table 26 lists minerals used in chemical production which are found in the Pacific Northwest or are readily importable.

There are few industries which can exist or even operate without a cluster of secondary or supporting industries That is to say, most industrial plants need chemicals and other types of products for use in their operations An oversimplified example can be given a shoe factory must not only be well supplied with raw leather, but it needs special types of nails, twine, glues, and polishes It is to such a factory's advantage that these other sources of semifinished materials be readily available at low costs within immediate reach of the plant.

The present situation in the Northwest is that, on the whole, supplies of certain important industrial chemicals and semifinished raw materials must be obtained over long distances, entailing additional transportation costs Every industry has specific requirements which may be related to those of other industries. For example, the basic material for rayon is high-grade dissolving wood pulp, of which the Pacific Northwest produces large quantities. However, the cellulose acetate process requires acetic acid, the most common source of which is calcium carbide. Consequently, if all other factors were equal, the establishment of a rayon plant would be dependent upon the establishment of a calcium carbide plant, one of whose derivatives would be

acetic acid Conversely, the feasibility of the establishment of calcium carbide plants would be enhanced by local markets for acetic acid In many respects the situation resembles the familiar riddle "Which comes first, the egg or the chicken?" But industrial co-ordination of this type is often highly necessary

2 *Fuel and Power* The balance sheet for the item of fuel and power reveals perhaps more definitely the eventual structure of the Pacific Northwest industrial economy Not unlike the Scandinavian countries, the Pacific Northwest has abundant sources of low-cost hydroelectric power Although there are extensive coal fields in the Region, the limited demand for such fuel, because of the availability of cheap waste wood or hogged fuel as well as the importation of fuel oil from California, has restricted the scope of operation of coal mines.

The tremendous water power of the Region is of primary importance in the probable industrial pattern, the stream regimen containing 45 per cent of the total potential hydroelectric power of the United States The Columbia River and its tributaries potentially could produce electric power equivalent to the entire output of electric utility plants of the nation in 1929. The development of this resource has already resulted in extremely low power costs and has focused attention on the Region as a coming electric empire

3. *Labor.* Because the prospective industrialist seeks a labor market which will furnish experienced men for specific operations, the Northwest situation is, upon first examination, not as favorable as in other regions. Labor in the Northwest lacks experience in diversified manufacturing although the development of skills can be expected The migration of peoples is bringing in many new skills The equable climate of the Region results in extremely high efficiency of labor and its workers are known for their rapid adaptability.

4. *Transportation.* Transportation is more likely than any other item to be placed in the liability column of the Northwest balance sheet. Although rail, water, air, and road facilities are as good as in other parts of the United States, distances between centers of population are great, the topography unfavorable, and transportation costs consequently high. In addition, the relative lack of diversified, large movements of commodities places the Northwest in a disadvantageous position with respect to rail tariffs of other regions On a tonnage-mile basis the inter- and intraregional rail rates are the highest in the nation. With the emergence of new industries, new rail rates will probably be negotiated, and the general tariff structures clarified and brought down to a more equitable and nondiscriminatory level.

Water haulage is of tremendous importance The emergence of an unparalleled fresh-water route to the Inland Empire may affect profoundly the transportation economics of the Region The improvement of navigation on the Columbia River is already having its effects on points west of the Cascades Deep draft vessels will shortly be able to travel 187 miles inland to The Dalles, and barge traffic will continue as far east as Lewiston, Idaho, more than 500 miles from the mouth of the Columbia Not only will agricultural and forest products be given an inexpensive outlet to the sea, and thus to all domestic and foreign ports, but, conversely, manufactures and raw materials of other regions gain cheaper access to that vast country, cradled between the mountains of the West.

5 *Markets.* The balance-sheet item of markets is one which is more in the liability than the asset column for the Northwest.

In an age when most manufactured goods are produced economically only in fairly large quantities, the size of a market to sustain an industry is necessarily great Industrial outputs therefore must reach a large number of people, and, if centered in the Northwest, must be spread over much larger areas than necessary (for example) in the heavily populated East or Middle West. This involves higher transportation costs, and consequently imposes severe restrictions as to the types of goods which can be sold competitively.

There are, generally speaking, three types of markets which a Northwest industry can reach The first is the local market, which for the four Northwest states embraces some 3,717,000 people This population is disseminated over one-eighth of the land of the United States In contrast, the metropolitan area of New York City has concentrated within a radius of some 50 miles from Manhattan Island well in excess of 12,000,000 people. This means that an industry locating in the Northwest and manufacturing only for the Regional market can expect only one-third as many potential customers, and must ship its goods infinitely greater distances than if it were located, for example, in New York City In the asset column, certain new industries would find little local competition within the Region.

The second type of market embraces the eleven western states with a population of, roughly, 13,000,000 people. There, again, distances are great, and transportation costs are high.

Not to be ignored are the national and export markets, where Northwest products would come into direct competition with similar goods from other industrialized regions. Here monopolistic and cartel price

control, tariffs, trade agreements, and many other similar items are formidable.

Recapitulating the market situation, it may be deduced that Pacific Northwest manufactured goods will find markets if (*a*) they are specialty products, which cannot be made readily elsewhere (this is true, for example, in forest products where the Pacific Northwest can well compete with other regions); (*b*) the products can be manufactured at lower costs than anywhere else, either by savings in raw materials, in labor, or in the fuel or power required by manufacturing or initial processing, (*c*) the product is one of particularly high quality for which the market is somewhat specialized, and transportation costs can be absorbed readily in the sales price.

PROBABLE PATTERN OF FUTURE NORTHWEST INDUSTRIAL DEVELOPMENT

Farm Chemurgy. Having in mind the balance sheet of the Region with its restrictive items, we may draw certain conclusions Farm chemurgy holds definite promise in the treatment of Northwest agricultural products such as apples, potatoes, and sugar beets However, this is just as likely to take place in other parts of the nation so that it is difficult to anticipate the types of development which may occur in the Pacific Northwest.

Plants Based on New Forest Products. In the field of forest products, there are many indications that technology will develop new uses. Already the Northwest plywood industry is finding increasingly diversified outlets for its products. Another major possibility is the establishment of cellulose plastics manufacturing on the Pacific Coast At present, Northwest high-grade dissolving wood pulps obtained primarily from Western hemlock are shipped to eastern points for manufacture into rayon. It is suggestive that very large quantities of rayon cord, used in the manufacture of automobile and truck tires, are then shipped west to Los Angeles, second largest rubber manufacturing center in the United States.

For the utilization of actual wood and mill wastes such as slabs and "hogged" fuel, the research worker and the engineer will no doubt evolve new processes. Pulp and paper plants must now dispose of large quantities of lignin, a waste material with great possibilities for future use in the manufacture of plastics The treatment of charcoal to make structurally strong, ash-free, high-purity carbon for electrometallurgical and electrochemical process offers another new field The utilization

of all present wood wastes would result in many added forest-products industries and be of tremendous value to the Region

Plants for Electrometallurgical and Electrochemical Products. To an amazing extent the Northwest possesses the raw materials needed for electrometallurgical and electrochemical products (Table 26). Manga-

TABLE 26

MATERIALS USED IN CHEMICAL PRODUCTION

(Available in Northwest or Readily Importable)

Water	Salt and fresh for oxygen, hydrogen, chlorine Sea waters on coast
Coal	Coking grade, W Wash, Vancouver Island, Alaska Bituminous and lignite in central Wash, Montana, Alberta, etc
Sulphur	Aleutian Peninsula, near Mt Adams in Wash, S E Idaho
Common Salt	S E Idaho, Utah
Limestone	N W and N E Wash, N E and S W Ore, central and S Idaho, Mont.
Sulphide Ores	Lead, zinc, copper, and iron sulphides widely distributed B C, Mont, Wash, Idaho, Ore
Petroleum	Central Montana and Alberta
Natural Gas	Central Montana, Alberta, S Central Wash.
Saltpeter	Small deposits, S Idaho, E Ore.
Potassium	Leucite in Wyo Alunite (potassium aluminum sulphate) in Utah and Nev
Gypsum	Montana, Utah, Wyo, Alaska, E Idaho
Lead	N. Idaho, N E Wash, N W Mont, Utah
Sand	Dune sand, coast, Ore and Wash, silica sand E and central Wash, and W. Idaho, and elsewhere
Aluminum	No bauxite Kaolin, E and W. Wash, and W Idaho For leucite and alunite, *see* Potassium
Chromium	Cent and S. Ore, N. Calif, N W Wash, Alaska, Philippines
Iron	N and central Wash, Northern Ore, central Montana, N and central Idaho, and elsewhere
Phosphate Rock	5,000,000,000 tons in S E Idaho, Utah, Wyo, and Mont
Copper	N. central Wash, S W. Mont, N E Nev, Alaska, B C, and elsewhere
Fluorine	Small occurrence, central Wash Extensive deposits in Colo
Arsenic	From copper ores in Mont, arsenopyrite common ore in N W By-product, Tacoma and Mont smelters
Magnesium	Magnesite and dolomite, N E Wash
Mercury	Central and S W Ore, W central Idaho, W central Wash.
Zinc	N E Wash, N Idaho, Butte, and W central Montana
Antimony	N. and central Wash and Idaho, S Ore
Barium	Small occurrences, central Idaho, N Calif, and Montana
Boron	Lake beds, S central Ore
Manganese	Butte and Phillipsburg, Mont, Olympic Peninsula, S W. Ore
Tin	Seward Peninsula, Alaska, imports from Bolivia and Malaysia Small shows in N E Wash and Idaho
Silver	N Idaho, Utah, Mont, N E Wash
Titanium	Small deposits, W Wash

nese and chromium are essential alloys in the basic steel industry. The light metals, such as aluminum and magnesium, are of growing importance in the manufacture of airplane parts, conductors for the

transmission of electric power, and other articles. Electric energy is available on an almost Region-wide network, at rates lower than anywhere else in the nation. The cost of producing these and other metals by electricity is sufficiently low to offer high hopes of national, perhaps even world, competition.

Likewise, a very large proportion of the production cost for electrochemicals is in the unit price of electric energy. Preliminary investigations of possible chemical industries in the Pacific Northwest on the basis of available raw materials, the enormous power resources of the Region, and fairly well determined markets indicate the possibilities.

Some of these new industries have already been established during the past two years (1939, 1940). The electrolytic conversion of alumina (from South American bauxite) into metallic aluminum is now being undertaken at a huge plant on the Columbia River near Vancouver, Washington. It is not improbable that other plants for the production of aluminum and utilizing Western raw materials will be established shortly in the Northwest. A plant for the manufacture of calcium carbide from Northwest lime and carbon is in initial production in Portland. Similarly, plans for the production of sodium chlorate are approaching fruition. A small pig-iron electric smelting plant is being erected near Vancouver, Washington.

It is therefore a reasonable conclusion that the Pacific Northwest is likely to become an electrometallurgical and electrochemical center.

The Human Factor. In terms of employment, what can be expected of these industries, inasmuch as modern technology makes them semiautomatic?

Although the basic industries are not the greatest users of labor hours per unit of product, the secondary manufacturing industries which fabricate basic products into finished articles use more labor per unit produced. Satellite industries to the basic industries also require less capital investment and more diversified labor. From this fact springs the importance of the establishment of basic industries in the Northwest, as they will tend to stimulate the wider development of related manufacturing industries in small villages as well as in large towns. Such a decentralization of industry, with its greater potential for open-air and healthful living conditions, would enhance human as well as economic values within the Region.

CHAPTER 25

FOREIGN TRADE OF THE PACIFIC NORTHWEST

By Frances M Earle

Throughout its entire settlement and development the Pacific Northwest has looked with favor upon foreign trade and a water-borne commerce. The rich furs reported by Captain Cook and later exploited by the warring fur companies were carried across the Pacific in sailing ships to be sold in China The California gold miners, too busy to grow their own food, paid boom prices for wheat harvested by Oregon farmers in the Willamette Valley Fir and cedar, cut in any convenient cove, could be sold readily and delivered cheaply anywhere around the fringe of the Pacific. Goods came also by sea. Land routes were long and uncertain, and the Region did the bulk of its business by water.

Other stimuli to a sea-borne commerce were soon set in motion. When Japan abandoned her policy of isolation in 1854 and opened her ports to the world, a new era of Pacific commerce was inaugurated Transcontinental railroads, first to Portland and later to Puget Sound, shortly provided the necessary connecting link with the eastern United States. In 1896 the Nippon Yusen Kaisya, in conjunction with the Great Northern Railway, established the first direct steamship line giving regular service between Seattle and the Orient. The great circle, shortest route to the ports of eastern Asia, was itself an advantage to Northwest traders and shipping men.

Then, with great rapidity occurred the opening up of Alaska, and the American acquisition of Hawaii and the Philippines. An even greater stimulus to ocean trade was the completion of the Panama Canal in 1914. With its tremendous economies in heavy freight costs, the new canal gave the Northwest competitive access to the Atlantic Ocean and to the markets of the Caribbean and of Europe It is little wonder, then, that foreign trade grew concurrently with all other economic activities and is today one of the watchwords of the Region.[1]

[1] The geographic basis for an accurate understanding of Northwest foreign trade—a comprehensive treatment of such factors as location and access, soil, climate, natural resources, and stage of industrial development—has already been laid in previous chapters

The Northwest Timber Ports

The water-borne commerce of the Pacific Northwest is handled through some twenty-one officially listed ports in Washington and ten in Oregon (Table 27) Some of these may include two or more cities,

TABLE 27

TONNAGE HANDLED BY NORTHWEST PORTS (1937)*

(Cargo tons of 2,240 pounds)

Washington:	Imports	Exports		Imports	Exports
Anacortes	5,245	17,608	Shelton	6,110	
Bellingham	12,795	63,241	Tacoma	324,685	280,326
Dupont		420	Vancouver	500	4,442
Eagle Harbor	4,392		Willapa Harbor	1,200	45,412
Everett	9,670	86,188	Total	948,905	1,150,861
Friday Harbor	60	93	Oregon		
Grays Harbor	200	234,574	Astoria	.	46,528
Kalama		8,135	Brookings	.	6,620
Longview	1,373	75,145	Coos Bay	..	194,929
Lopez	30	10	Portland	137,529	428,526
Olympia	498	32,441	Prescott		2,269
Orcas	139	303	Rainier		717
Point Wells	..	725	St Helens	2,000	5,036
Port Angeles	210,291	19,128	Warrenton		2,014
Port Gamble	..	4,645	Wauna		4,962
Port Townsend	45,330		Westport		1,702
Seattle	326,387	278,025	Total	139,529	693,303

* "Volume of Water-Borne Foreign Commerce of the United States by Ports of Origin and Destination," for the fiscal year 1937 Report 42-37, U S Maritime Commission, 1939

for instance, Aberdeen and Hoquiam are both in Grays Harbor, and Coos Bay includes Marshfield and North Bend This long list of shipping centers would present a complicated problem for trade analysis except for one basic fact in regional economy. Timber and the great array of products made from it—lumber, plywood, siding, piling, shingles, woodenware, pulp and paper, etc—are the prime materials providing most of the incoming and outgoing tonnage for virtually every one of the smaller ports on the Northwest seaboard. Some twenty-five of the thirty-one handle nothing else of real importance. Heavy imports of materials for harbor construction sometimes increase the tonnage, as at Port Angeles in 1937.

Consequently, no matter what their size, a remarkable similarity is found in the port functions and cargo handling of these timber economy towns Incoming log trains, mills at the water front, and freighters loading directly at millside are the usual pattern. Timber and its products account for 98 per cent of Grays Harbor exports; this center is now the leading lumber-shipping port of the United States.

Even in cities such as Everett, Bellingham, and Astoria, where there are other activities and a more diversified economy, timber derivatives provide 90 to 95 per cent of the exports Likewise, the import tonnage listed by a number of the mill cities on Puget Sound consists in the main of logs or partially manufactured wood brought in from Canada for further processing

A number of these timber-shipping towns are described in more detail in the following chapter

The General Cargo Ports

The handling of general cargo, including the entire range of raw materials for industry, machinery of every type, foodstuffs from all over the world, and the thousands of manufactured items for human use, is concentrated mainly in three of the Northwest ports—Seattle, Portland, and Tacoma It should not be inferred that these major ports play no part in the timber economy previously discussed, an examination of Tables 28 and 29 will show that the wood products handled through Seattle and Portland compare favorably with the tonnages shipped by most primary timber ports In the three larger seaports, however, timber, with its manufactures, unquestionably a dominant trade commodity is only one among a list of others, many of them far more valuable per ton These cities might even be called multiple-function ports to distinguish them from the smaller single-function ports.

The three major ports, all far inland from the ocean, have taken the lead in Northwest trade because of a number of interrelated factors. An early start, strategic location, favorable access to agricultural hinterlands or raw materials, good harbors (natural or dredged), railway access to the East, and capital for development, all have played a part in varying degree.

Portland, at the outlet to the richest agricultural valley in the Northwest, had an early start and the advantage of Columbia River navigation It had the first transcontinental railway connection with the East by way of the Columbia gap through the Cascades, and still has an advantage over its sister ports for the Inland Empire trade The problem of handling larger ocean freighters was solved by dredging a deep water harbor in the Willamette River, and cutting a forty-foot channel through the bar at the mouth of the Columbia. Tacoma had the first railway to Puget Sound and an excellent anchorage on Commencement Bay which has since been expanded by dredging several basins in the flats at the head of the bay. Seattle, with a slower start

TABLE 28

FOREIGN COMMERCE OF THE PORT OF SEATTLE, 1929–1940*

(Short tons)

Imports	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
Animals and animal products	19,165	30,531	22,493	22,973	21,424	14,301	18,685	23,953	38,187	18,870	15,066	17,727
Vegetable food products	81,527	48,559	29,888	23,262	56,933	58,814	96,456	116,833	136,523	66,470	70,068	77,058
Vegetable products, inedible	8,060	24,785	7,747	5,780	7,589	8,375	18,012	12,389	11,517	7,408	2,075	5,284
Textiles, fibers, silk	51,637	33,818	26,943	20,104	28,219	20,028	19,194	15,838	16,487	7,316	7,303	7,502
Wood and paper	112,898	100,657	91,705	147,519	125,253	84 525	123,958	59,669	95,840	63,858	83,413	80,223
Nonmetallic minerals	138,557	110,872	54,300	36,196	35,858	76,786	58,069	68,060	102,121	71,840	68,340	57,107
Ores, metals, and mfrs	28,525	16,766	13,403	6,419	8,304	10,734	8,676	13,160	16,508	8,003	6,856	11,073
Machinery and vehicles	524	1,068	429	478	149	273	609	858	355	150	204	100
Chemicals	23,781	33,069	20,123	18,202	18,770	15,453	14,061	23,641	20,626	28 831	27,685	10,378
Unclassified	10,113	6,552	6,370	3,561	5,778	5,338	7,077	7,448	4,434	2,226	4,870	16 360
Total Imports	474,787	406,677	282,401	283,994	308,277	258,769	304,797	341,849	451,604	275,080	291,101	300,861

Exports	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
Animals and animal products	30,737	27,027	24,620	22,570	23,732	25,721	26,633	22,814	18,963	27,310	25,247	35,020
Vegetable food products	302,910	269,505	314,520	174,511	182,386	312,627	127,276	89,760	139,052	198,051	274,732	117,794
Vegetable products, inedible	3,485	1,596	1,471	820	1,110	1,324	2,305	2,17[illegible]	3,160	3,105	1,500	3 058
Textiles	7,501	4,282	1,355	914	1,043	828	1,619	1,258	2,277	1,250	2,233	3,094
Wood and paper	217,101	136,576	157,382	124,357	132,745	163,919	146,540	137,630	136,661	66,180	87,529	123,051
Nonmetallic minerals	25,220	12,684	8,176	4,986	11,505	22,405	39,642	25,370	36,270	30,333	31,063	15,938
Ores, metals, and mfrs	37,066	31,498	12,498	21,856	32,020	39,660	47,793	29,766	67,250	51,530	111,133	175,308
Machinery and vehicles	21,527	14,032	6,030	3,140	4,835	7,433	7,402	6,169	11,386	5,229	4,332	3,806
Chemicals	10,660	3,667	2,062	4,142	3,498	6,873	5,251	2,391	3,604	2,734	5,119	3,632
Unclassified	7,105	4,094	7,756	2,259	2,567	3,160	4,941	3,796	7,670	9,454	7,085	2,885
Total Exports	633,312	504,961	535,870	359,561	395,450	583,920	409,402	321,456	427,231	395,275	548,963	455,025

* Corps of Engineers, U S Army and U S Maritime Commission

TABLE 29

FOREIGN COMMERCE OF THE PORT OF PORTLAND, 1929–1939*

(Short tons)

Imports	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939
Animals and animal products	2,864	1,196	324	1,186	2,119	1,635	3,336	3,454	4,485	1,435	3,556
Vegetable food products	38,711	28,590	15,117	18,307	22,220	20,122	68,838	82,178	81,462	28,175	31,305
Vegetable products, inedible	42,181	42,048	30,618	39,155	42,413	33,903	61,104	41,221	41,026	36,185	38,689
Textiles, fibers, silk	9,458	10,709	5,440	3,867	6,665	6,516	10,433	10,996	12,847	15,530	15,948
Wood and paper	3,903	3,265	11,132	2,656	2,961	4,469	4,096	4,764	2,083	2,147	1,119
Nonmetallic minerals	15,921	9,284	5,443	3,311	8,174	6,393	9,235	8,425	12,241	5,478	6,653
Ores, metals, and mfrs	13,006	13,825	12,588	6,430	5,131	2,669	7,383	7,437	8,331	6,067	4,764
Machinery and vehicles					57	36	189	432	332	82	106
Chemicals	7,028	8,912	5,640	2,148	4,747	3,652	4,309	2,928	5,270	4,164	2,919
Unclassified	4,346	3,579	1,865	1,744	413	189	283	210	337	296	102
Total Imports	137,418	121,408	91,627	78,854	94,450	79,284	169,216	162,045	168,774	99,559	105,261
Exports	**1929**	**1930**	**1931**	**1932**	**1933**	**1934**	**1935**	**1936**	**1937**	**1938**	**1939**
Animals and animal products	2,470	2,422	2,205	2,096	2,615	4,126	5,727	2,569	954	871	571
Vegetable food products	780,564	746,817	621,632	297,741	210,080	467,529	104,832	104,040	212,269	431,701	595,998
Vegetable products, inedible	601	479	206	581	581	741	839	687	1,924	1,136	1,067
Textiles	1,161	63	374		46	189	527	70	73	11	223
Wood and paper	700,520	478,464	450,626	268,748	287,639	284,154	297,142	258,330	276,408	183,871	206,120
Nonmetallic minerals			211	45	150			78	110	59	247
Ores, metals, and mfrs	11,108	5,824	743	3,255	19,357	36,602	67,378	57,504	137,658	80,938	177,064
Machinery and vehicles	594	244	284	195	349	484	835	267	476	135	177
Chemicals	2,802		192	5	62	226	412	53		9	6
Unclassified	474	674	373	253	203	313	194	308	313	141	88
Total Exports	1,500,294	1,234,987	1,076,846	572,961	521,140	794,372	477,911	423,935	630,308	698,986	981,561

* Corps of Engineers, U S Army and U S Maritime Commission

TABLE 30

Foreign Trade of the State of Washington*

(Value of Leading Commodities)

Exports	1935	1936	1937	1938	1939	1940
Wood and wood products†	$15,972,524	$18,167,375	$24,806,307	$11,761,112	$12,689,051	$11,163,970
Wheat and flour	1,333,934	1,734,555	5,589,880	5,750,750	7,469,506	7,373,841
Fish and fish products	4,718,190	5,381,728	5,411,198	5,919,228	5,325,188	6,668,164
Fruits and vegetables	8,313,689	9,379,546	9,667,758	8,804,915	8,130,327	3,001,653
Cattle, hides, and skins	354,790	287,827	1,589,793	1,830,339	1,125,740	718,143
Refined copper	3,973,134	6,304,215	19,088,891	14,641,109	18,834,884	3,902,241
Machinery	2,559,333	3,439,627	4,503,593	3,453,667	2,949,719	6,485,828
Motor vehicles and parts	2,019,131	2,182,588	3,706,730	1,311,323	1,224,245	1,208,856
Aircraft and parts	138,454	2,012,127	554,388	995,731	1,192,544	30,534
Petroleum products	792,752	797,358	1,044,009	1,005,020	954,257	510,507
Chemicals and explosives		482,455	958,848	1,024,685	1,622,278	2,550,618
Steel, mfrs., and scrap	802,924	673,855	1,433,271	989,298	2,221,255	4,987,833
Ferro alloys				606,668	3,182,308	53,929
Evaporated milk	436,839	432,668	366,613	428,928	521,958	1,431,835
Electrical goods			823,401	532,154	474,991	573,414
Textiles, fibers, and manufactures				369,914	596,864	811,807
Books and printed matter	278,660	857,292	639,803	693,490	708,377	682,012
Total Exports	$49,534,919	$61,990,964	$92,566,594	$69,085,371	$78,334,630	$87,338,353

Imports	1935	1936	1937	1938	1939	1940
Wood and wood products†	$ 7,559,043	$ 6,172,978	$ 8,335,765	$ 7,451,348	$11,517,342	$13,286,851
Silk	4,072,510	4,782,372	3,766,470	3,765,595	4,566,835	8,315,956
Sugar	1,485,418	2,017,178	2,274,686	2,172,306	2,126,322	1,242,318
Fish and fish products	1,020,012	1,004,658	2,100,129	1,379,243	1,627,743	1,910,868
Coffee	915,650	993,305	1,353,799	1,465,001	1,156,888	1,142,918
Tea	682,325	664,670	1,151,759	690,021	850,021	1,164,315
Fertilizers			778,509	595,545	926,976	1,054,961
Animals and animal products	182,047	1,740,448	1,576,642	424,698	1,159,320	1,362,640
Whisky	454,170	1,213,097	1,025,919	658,348	697,709	610,0[illegible]4
China and earthenware	726,673	755,060	1,042,877	621,183	688,141	878,776
Creosote oil	343,666	577,237	685,069	655,256	683,545	319,190
Copper ores and concentrates	3,934,183	3,014,176		864,610	575,798	1,695,167
Undressed furs	416,119	652,202	654,630	400,221	549,236	750,691
Coconut meat	329,158	426,546	751,807	231,465	153,513	
Corn	1,081,969	1,136,152	1,576,273			
Cotton mfrs			706,255	203,705	377,947	240,152
Oil cake and oil-cake meal	322,043	546,083	944,178	256,744	214,385	299,754
Tung oil—Chinese	2,389,357	1,392,312	738,200	370,067		
Jute burlaps and bags	763,917	589,437	484,892	215,964		
Total Imports	$33,758,026	$37,262,526	$39,803,591	$29,274,180	$34,409,521	$41,914,6[illegible]3

* Data from U S Customs, Seattle
Washington Customs District does not include Longview
Comparable data not available for Oregon
† For more detailed wood-products classification, see Table 31

than Portland and poorer access to the East, has capitalized its fine natural harbor on Elliott Bay and its superior location for trade with Canada and Alaska. With the steady growth of water-borne traffic Seattle became the headquarters for more steamship lines than any of the other ports, and expanded its harbor facilities to include the lower Duwamish flats, Smith Cove, Salmon Bay, and even lakes Union and Washington. All three ports now have ample facilities for handling all types of ocean traffic, equal access to Northwest power and raw materials, and approximately similar rail connections with the eastern United States.

Commodities in Foreign Trade

In an early report on Northwest trade, Hittell wrote "During 1880 considerable shipments of flour were made from Walla Walla to Liverpool, and 160,000 cases of salmon were shipped to foreign countries from the Washington side of the Columbia River About 170,000,000 feet of lumber were shipped to San Francisco, the Sandwich Islands, and Australia, and 200,000 tons of coal were shipped to various destinations."[2] This sixty-year-old account of the leading export

TABLE 31

FOREIGN TRADE IN WOOD AND WOOD PRODUCTS, WASHINGTON*

(Thousands of dollars)

	1938	1939	1940
Imports			
Softwood logs	1,483	2,258	2,043
Cedar siding	599	976	1,969
Poles	—	206	227
Red cedar shingles	2,199	3,288	2,976
Wood pulp	778	1,315	1,415
Newsprint	1,734	2,255	3,273
Softwood boards	658	1,219	1,247
Wood baskets	—	—	136
Total imports	7,451	11,517	13,286
Exports			
Douglas fir logs	623	550	206
Other softwood logs	—	189	110
Douglas fir timber	624	1,104	1,323
Douglas fir lumber	2,334	3,895	3,425
Other softwood lumber	538	1,326	1,785
Hemlock and spruce box shooks	244	362	443
Wood pulp	6,819	4,583	1,912
Newsprint	327	404	1,037
Papeteries	252	276	922
Total exports	11,761	12,689	11,163

* U S Customs, Seattle

[2] Hittell, "The Commerce and Industries of the Pacific Coast of North America," 1882, p 215

items has a familiar ring even in 1941. Coal is no longer significant, but lumber, salmon, and flour have continued to hold a dominant position.

Types of commodities handled through Seattle and Portland appear in Tables 28 and 29 The general picture is somewhat similar for both, but a careful analysis shows a number of significant differences. In total tonnage Portland was formerly the unquestioned leader, but since 1932 the volume has tended to remain about the same for both cities. Portland has much greater exports, shipping in recent years twice the tonnage of wood and paper and twice as much farm produce. Wheat and flour for foreign markets are two of the big items in Portland's freight. On the average, two tons of Northwest goods for foreign markets are loaded in the Willamette and sent down the Columbia for every ton similarly dispatched from the Seattle water front.

Seattle takes the lead in imports, and for many years has handled an average of three times the tonnage reaching Portland harbor from abroad. This import preponderance over Portland is greatest in wood and its products, newsprint, agricultural produce, metallic and non-metallic minerals, chemicals, and manufactured goods from the Orient One historic and valuable import, however, has declined to relative insignificance. Much of Seattle's phenomenal increase in the value of imports during the 1910-1929 period (see Table 32) was due to the large amount of raw silk from Japan, trans-shipped by fast freight to eastern industrial centers. The Washington Customs District reported total imports valued at 216 million dollars in 1929, of which raw silk accounted for 151 million, or 69 per cent of the total. First the economic depression and, later, rival silk routes via California ports or the Panama Canal cut silk imports through Seattle to 4½ million dollars in 1939—a mere fraction of its former value.

Two-thirds of Tacoma's exports originate in Northwest forests. Wheat and flour are exported in quantity, chiefly to eastern Asia, and refined copper from the huge local smelter is widely sold in normal times. There is also a growing export of local manufactures. Three-fourths of the import tonnage consists of copper ores and concentrates from Russia, British Columbia, South America, Australia, and Mexico

For all these ports it should be mentioned that the domestic and intercoastal trade not only is larger, but also includes a greater variety of commodities.

Direction of Foreign Trade

Both the volume and the direction of Northwest trade were affected by the prolonged world war of 1914-1918, by the boom of the late

TABLE 32

Northwest Foreign Trade by Customs Districts*

(Millions of dollars)

Year	Washington †		Oregon		Total	
	Exports	Imports	Exports	Imports	Exports	Imports
1900	17	7	8	1	25	8
1913	62	51	13	3	75	54
1920	192	134	61	8	253	142
1921	90	58	68	4	158	62
1922	90	218	51	7	141	225
1923	116	262	52	10	168	272
1924	134	270	62	10	196	280
1925	120	261	41	12	161	273
1926	147	261	78	13	225	274
1927	129	239	78	14	207	253
1928	150	229	63	12	213	241
1929	153	216	66	19	219	235
1930	102	113	46	10	148	123
1931	67	55	28	5	95	60
1932	36	35	15	4	51	39
1933	37	28	14	4	51	32
1934	53	23	22	4	75	27
1935	49	33	17	8	66	41
1936	61	37	16	8	77	45
1937	92	39	27	10	119	49
1938	69	29	29	7	98	36
1939	78	34	30	8	108	42
1940	87	41	28	7	115	48

* Bureau of Foreign and Domestic Commerce

† Washington Customs District does not include Longview, which is grouped with Oregon

1920's, ending in the market crash of 1929, by the world-wide economic depression of the early 1930's, and by the Sino-Japanese war, which was soon followed by the second world war (Table 32). There has been a complete loss of markets in some countries, as well as new or increased trade with others.

The trade of the Washington Customs District by countries shows the general trend of the years 1935-1940 (see Tables 33 and 34) Japan consistently took one-fourth to one-third of Puget Sound exports The increase in shipments to Japan after 1937 consisted largely of ores, scrap metal, and petroleum products. In 1940 scrap metal represented ap-

TABLE 33

EXPORTS OF THE WASHINGTON CUSTOMS DISTRICT*

(Millions of dollars)

Exports to:	1935	1936	1937	1938	1939	1940
Japan	13.9	14.6	25.0	18.2	22.7	20.5
Canada	9.0	13.6	17.7	14.2	15.3	15.8
United Kingdom	10.0	10.7	13.0	10.4	11.5	15.4
U. S. S. R.					2.8	10.0
Philippines	3.8	4.6	7.3	5.8	5.2	5.6
China	2.8	4.6	4.0	1.3	2.6	5.5
Germany	1.6	2.4	5.3	3.7	1.0	.
France	1.4	2.5	5.1	2.1	2.2	.8
All others	7.0	8.9	15.2	3.4	15.0	13.7
Total	49.5	61.9	92.6	69.1	78.3	87.3

* Comparable data for Oregon are not available

TABLE 34

IMPORTS OF THE WASHINGTON CUSTOMS DISTRICT

(Millions of dollars)

Imports from:	1935	1936	1937	1938	1939	1940
Canada	12.2	14.1	15.4	12.5	17.4	21.0
Japan	7.3	8.2	9.6	6.8	8.3	12.5
Philippines	2.3	3.2	3.8	2.9	3.1	2.4
China	3.2	2.5	1.8	1.0	.5	.5
All others	8.7	9.2	9.2	6.0	5.1	5.5
Total	33.7	37.2	39.8	29.2	34.4	41.9

proximately one-fourth of the foreign export tonnage of Seattle. Japan was also the largest purchaser of wood and wood products, which were landed chiefly at Yokohama and Osaka.

Canada ranked second as a customer, and the United Kingdom third. War demand for foodstuffs and building materials (especially lumber and plywood) caused the increase in shipments to the United Kingdom. Markets in France and Germany were lost after the beginning of the war. The war effectively closed nearly all Europe to Northwest boxed fruit; in 1938 apple and pear exports through Seattle were 95,869 tons, but by 1940 shipments had declined to 5,622 tons. The Philippine Islands took the larger share of flour exported. Sales to the U. S. S. R. were negligible until 1939, when copper, wheat, and oil pipe which would normally reach Russia via the Atlantic were re-routed via the Pacific to Vladivostok. In 1940, 10 million dollars worth of cargo went from Puget Sound ports to the maritime provinces of Siberia. In the south Pacific, canned milk, formerly supplied by the Netherlands, was shipped from the United States, the sale of evaporated

milk more than tripled in five years, amounting to $1,431,835 in 1940. Exports to war-torn China continued and even increased

About one-half of the value of all commodities imported from foreign countries was from Canada (21 million out of a total of 41 9 million in 1940) with shingles and wood pulp among the larger items. Japan held second place, shipping raw silk, tea, pottery, and earthenware, and a variety of miscellaneous items including toys. Imports from the Philippine Islands were principally copra and sugar The blockade of her ports after 1937 greatly reduced shipments from China.

Conclusion

While it is quite true that foreign trade is of far less total value to the Northwest than its huge commerce with the rest of the United States, including Alaska and Hawaii, the import and export business has long been an integral part of the regional economy In spite of occasional optimistic statements to the effect that foreign markets might be lost and increased domestic sales take their place, the Northwest is determined to keep both sources of revenue, and even increase them if possible.

It is a matter of some concern, however, that both foreign and domestic commerce are based so heavily upon one local resource—the softwood forests Wood products are at present the very heart of both types of trade The recent trend, fortunately, has been away from the export of crude material at a low price, and toward the sale of more highly processed and valuable wood manufactures. There has also been a welcome increase in the sale abroad of more agricultural, industrial, and chemical products and, in the future, the Region may be able to widen still further the range of its exportable goods

It should be pointed out that in many of these lines the position of the Northwest is at best highly competitive. Other parts of the world have as good or better agriculture and are certainly more advanced in most of the manufacturing techniques Few other parts of the world have as workable a supply of softwoods—as is attested by their eagerness to fill their needs in the Northwest. Other regions failed to make their forests self-sustaining and perpetual. This pertinent fact possibly points the way toward the one sound policy for the continuation of foreign trade in the future.

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Numerous reports giving trade statistics are issued by the following Consult their lists of publications.

U S Department of Commerce, Washington, D C
U S Maritime Commission, Washington, D C
U S Customs Service, Seattle, Washington

PART VI

POPULATION

CHAPTER 26

TOWNS AND CITIES OF THE NORTHWEST

By Hallock F Raup[1]

Except for the large urban centers, northwestern settlements usually reflect the leading occupations of the people. The settlements fall into four major groupings those in which human activities are agricultural, those having lumbering as the principal occupation, the transportation centers, and the mining towns. Relatively few settlements are the result of military activity, governmental organization, or the presence of state institutions. Rural settlements are of greater importance than in most other parts of the United States except the South and Middle West. The smaller cities and towns of the Region were started so recently that it is generally possible to classify them with respect to function, origin, and site.

Unlike many other parts of the United States, the settlements of the Northwest have changed their original characteristics but little. A mining center seldom changes character throughout its existence, and either progresses or declines. Some of the towns, of course, have multiple interests: Spokane is both a transportation center and a market and supply center for surrounding farms; but it is much more common to find towns such as Bend, Oregon, specializing in lumber production. More than in other sections, the Northwest towns were planned before their settlement This is true of all types, such as Anacortes (a transportation center), planned in 1876, Kelso (agriculture and lumber), planned in 1884, Holden (mining), planned as recently as 1936; and Longview (lumbering and shipping), planned in 1922. The city of Everett was plotted as both a lumber-sawing and iron-working city although the iron works failed in permanence.

LUMBER SETTLEMENTS AND TOWNS

Those settlements whose major interests are concerned with the cutting or processing of lumber products are located in two general

[1] Many persons assisted in the preparation of this chapter Among them were J Norman Carls (for Portland), N F G Davis (for Victoria and Vancouver), J D Forrester (Butte and Idaho cities), O W Freeman (Spokane and other centers), H H. Martin (Seattle), and Gertrude L McKean (Tacoma)

regions: the western portion convenient to tidewater and east of the Cascade crest, the forested interior mountains and plateaus. Of these two regions, the former is the more important Most of the lumber settlements are relatively small, in spite of the fact that 60 per cent of all wage earners in the Northwest are employed in some capacity in connection with the lumbering and woodworking industries. Some of the settlements are no more than temporary camps, which disappear with hardly a trace when their timber stand is exhausted, but others, near sawmill sites, are more permanent and support a larger population during their periods of activity. Since most of the lumber sawed in the Northwest is used elsewhere in the United States or abroad, most sawmill centers, either in coastal or interior locations, are lumber export cities. Some of the sawmill towns are "company towns," with nearly all their residents employed by a single mill, like the village of Aloha, on the Olympic peninsula.

Western Lumber Cities. A preferred location for the lumber mill is at tidewater, where cargoes can be loaded directly into ships from storage yards and sawmills. Nearly all the coastal cities and towns of Oregon, Washington, and British Columbia owe much of their importance and growth to lumber-export activities, and numerous places are almost entirely dependent upon lumbering for their support. Among such centers are Port Orford, Bandon, Marshfield, Astoria, South Bend, Hoquiam, Aberdeen, Port Angeles, Everett, and Bellingham. The three large cities on Puget Sound, Seattle, Vancouver, B C , and Tacoma are likewise materially benefited from the lumber-export trade, as are the capital cities of Victoria and Olympia to a lesser extent. On the Columbia River, Portland, Vancouver (Washington), St Helens, Longview, and Kelso furnish other examples. Even west of the Cascades some sawmills are located where railroads alone furnish transportation for the export lumber. For example, Enumclaw has a large mill, and Centralia, Chehalis, Eugene, and Oregon City are other examples Bothell, now a suburb of Seattle, owes its existence to a former sawmill site

Interior Lumber Centers At interior locations east of the Cascades rail transportation to market is a prime consideration in the location of large permanent sawmill towns Intermountain lumber centers include Klamath Falls, Bend, Burns, Prineville, The Dalles, Pendleton, La Grande, and Baker in Oregon; Spokane, Newport, Deer Park, Okanogan, and Omak in Washington, and Lewiston, Potlatch, and Coeur d'Alene in Idaho. Saint Maries, Idaho, is more a headquarters for logging operations than for lumber sawing. Bonner, Polson, and

Libby are among the Montana lumber towns. Sometimes temporary sites are established near a stand of timber without adequate rail service, as at Lincoln during operations of the Grand Coulee Reservoir site, and then lumber must be hauled to market by truck. Some of these settlements, towns, and cities have satellite industries connected with lumbering, such as the manufacture of pulp and paper, an especially noteworthy paper-mill town being Camas.

Klamath Falls. One of the interior centers, Klamath Falls, is a good example of the pattern of a lumber-mill city (Fig. 126). To a certain extent, "boom town" characteristics are present, for Klamath Falls experienced a population increase from 4,801 in 1920 to 16,093 in 1930. This rapid growth was the direct outcome of the construction of the Klamath Falls-Eugene link of the Southern Pacific Railroad, which made this part of southern Oregon accessible for the first time. Crossing the Cascade range at Odell Lake, this route superseded the Rogue Valley line as the main connection between Oregon and California. In 1929, a rail connection with Alturas, California, tapped the eastern hinterland of Klamath Falls for its lumber, potatoes, livestock, and grain.

The trade area of the city of Klamath Falls is not entirely concerned with lumber, but elements of diversified activity are present. The lumber industry, however, exceeds agriculture in value, and draws pine logs from higher elevations bordering Upper Klamath Basin. It keeps Klamath Falls in first rank among Oregon pine-milling towns. A related but unique item in the city's prosperity is the inclusion of the timber-rich population of the Klamath Indian Reservation within its trading area. The physical appearance of the city indicates its interests clearly, because on all sides the waste burners of the mills send out clouds of smoke over the large wooden buildings. It should be noted that Klamath Falls, in common with many other lumber towns, is built largely of wooden materials except for the most modern buildings of the business district.

Important Sawmill Cities. One of the distinctive lumber towns is the city of Longview, Washington, which, in contrast to the disorder of most settlements, was planned before it was settled as a community for the laborers in its mills. It is, in one sense, a "company town" on a large scale, laid out in 1922; by 1926, its population exceeded ten thousand. Longview was planned as a permanent shipping and handling point for lumber removed from near-by stands of Douglas fir, since it has excellent rail connections and its wharves can be reached by ocean vessels.

Centers of lumber export have certain recognizable characteristics. The larger cities like the Grays Harbor ports as well as Everett, Port Angeles, and Longview have finer buildings and are permanent substantial cities, whereas some of the smaller places have a slipshod ap-

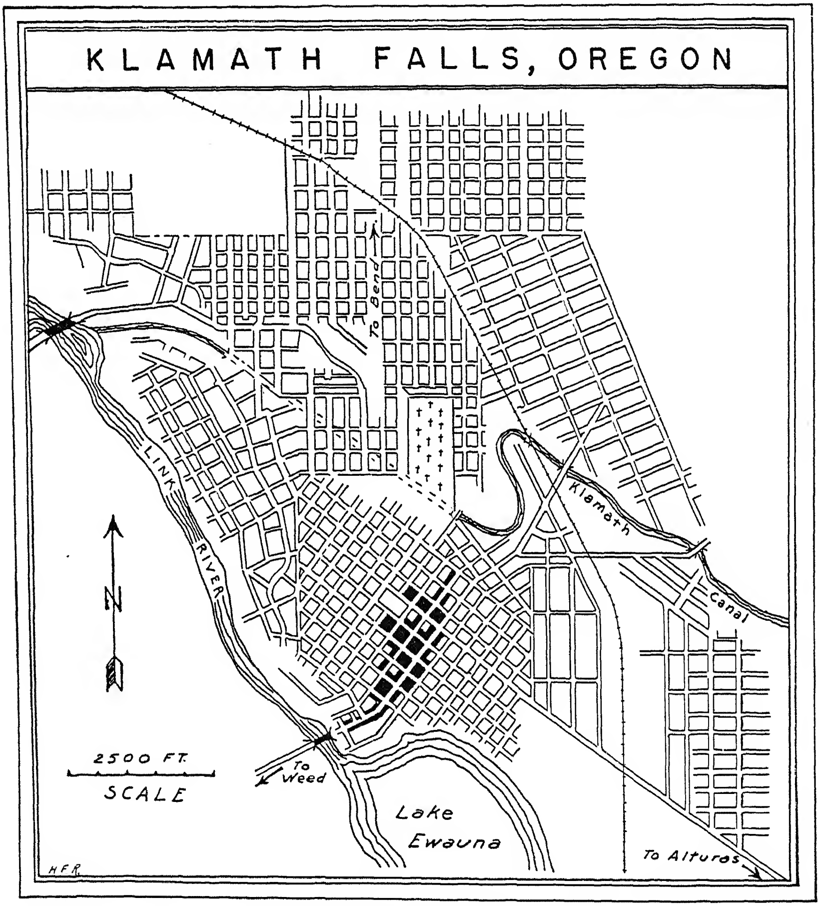

FIG. 126. Plan of Klamath Falls.

pearance that emphasizes their temporary character; but in either case the dominant features of the cultural landscape are the big sawmills and storage yards. The tendency of these towns is in the direction of consolidation of the industry into larger and more efficient mills, although temporary portable or semiportable outfits may operate on some stand of timber which is too small or too distant for the larger companies to cut.

Alongside the big mill, with its stacks and refuse burner, are the wharves and adjoining storage yards at which the tramp steamers and lumber schooners tie up. Clustered near the mill are the houses of the workmen, built with different degrees of permanence. In some towns, "company houses," cut from the same architectural pattern, have been supplied, but this is more common in the smaller places. In larger

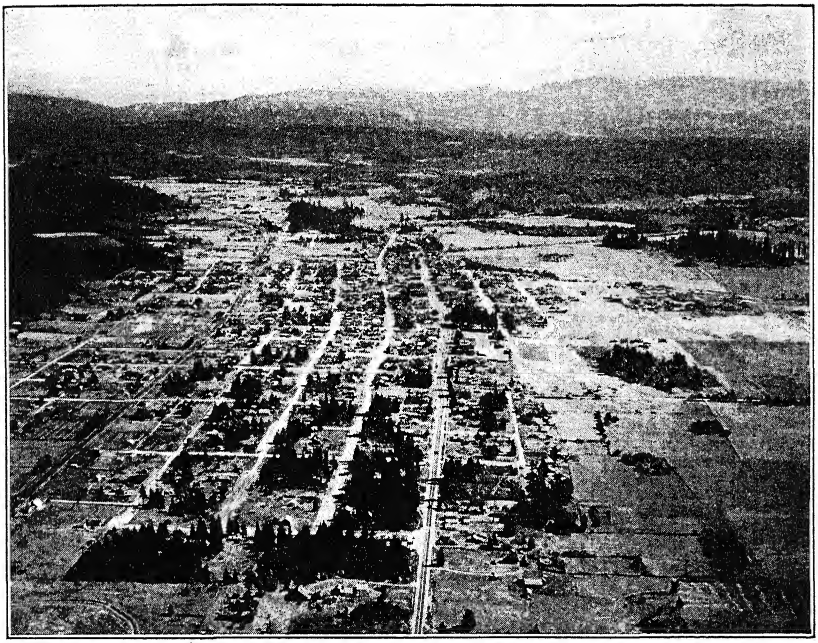

FIG. 127. Elma in western Washington, located in a lumbering region of declining importance. The Washington State Planning Commission has made a survey of this community to find possible industries to replace logging. (Photograph by *41st Div. Aviation, Washington National Guard.*)

towns the company does not need to provide housing. The business section is seldom as large as that of a farm-supply center of equal population in the intermountain country because the rural population near a sawmill town is usually small; and often a sawmill center is literally a community in a forest wilderness without industries other than woodworking to support it. Some mill centers such as Spokane, Everett, and Grays Harbor now must receive their log supply from a distance because the near-by timber has been cut. The interior mill towns usually have other industries to support them in addition to simple lumbering, so their business sections are larger in proportion than those of equal size west of the Cascades.

Problems of Lumber Towns When the lumber is exhausted, sawmill towns often have a difficult time of readjustment At Elma, Washington (Fig. 127), the State Planning Council is helping conduct a careful survey to investigate the possibilities of other industries which might be developed after the removal of the virgin timber Among other towns facing the prospect of survival after the closing of mills are Spirit Lake and Harrison, Idaho, and Bandon, Oregon. Occasionally, towns in an attractive location, such as Bandon or Coeur d'Alene, can attract tourists as a partial substitute for the passing of the lumber mills. Some of the former mill sites have been revived in this way.

Without other resources to which their inhabitants might turn for an income, many mill sites have been entirely abandoned. Such "ghost towns" have depressing cultural landscapes, dominated by the big mill slowly crumbling to ruin with its cold and rusty beehive-shaped sawdust burner. Most of the houses were cheaply built, but usually there was some degree of permanence Then the timber was cut off, the mill closed, the burners no longer exhaled black smoke, and the residents left the community. Sometimes buildings were torn down, others were destroyed by fire Unless other resources were found on which to base a new economy, the town might be entirely gone and its very site forgotten. Carlisle on the Olympic peninsula, Harrison on Coeur d'Alene Lake as well as the towns of Elk and Loon Lake, near Spokane, and McInnis Mills in Pend Oreille County are examples of such settlements Former lumber towns whose names no longer appear on the map of Washington include Branham, Buckeye, Cedarville, Day City, and Clipper.

THE AGRICULTURAL SETTLEMENTS

The eastern parts of Washington and Oregon and the southern part of Idaho, because of weather conditions and lack of forest cover, are devoted to agricultural pursuits and grazing on a fairly extensive scale, although the Willamette Valley and the Puget Sound Lowland, west of the Cascades, specialize in dairying and fruit growing. The agricultural towns of the interior are usually less complex in development and function than those of the coastal regions. They may be either market centers or supply centers for the surrounding farms, or a combination of the two. Spokane and Walla Walla, for instance, are supply centers and also market centers for both grain and fruit growers, whereas Colfax, Washington, is chiefly a supply center for wheat growers and Yakima or Wenatchee for fruit. Moscow, Idaho, and Davenport, Lind, and Ritzville, Washington, are other examples of

supply centers for wheat farmers Idaho Falls, Twin Falls, and other southern Idaho cities are market and supply centers in irrigated districts that have a variety of products.

The trade centers vary from a general store or a few simple services for farmers, such as a grain elevator or warehouse, grocery, gas station, hardware, and implements, through semicomplete settlements, up to larger and more complex urban communities with a large variety of stores, businesses, and complete professional services Certain types of business, such as banking, theaters, hotels, newspapers, hospitals, furniture, fashionable clothing, automobiles, and expensive machinery are usually concentrated only in the larger centers In this day of automobile travel a trip of fifty or a hundred miles or more is practicable when making larger purchases.

Wheat Centers In a region like the Palouse where most of the land is tillable, both farms and supply towns are quite evenly distributed through the country area, but in irrigated sections there is a tendency toward concentration. The specialty production of wheat on the dry-land farms requires rail facilities for marketing the crop At intervals of about ten miles in the best wheat regions, and twenty to thirty miles in the drier country, the shipping and supply towns are strung along the railroads. Both towns and rail lines occupy the valleys because of ease of construction, which is a convenience in hauling the wheat downhill to market Often the towns, lying as they do below the horizon of the hilltops, are invisible until they are approached closely The shift from handling wheat in sacks to shipping in bulk has changed the skyline of the wheat centers because in recent years the low warehouses once sufficient for sacked grain have been replaced by hundreds of high elevators throughout the wheat-growing areas

Many of the towns situated in valley bottoms have a restricted town site, and their pattern tends to be greatly elongated parallel to the rail line, with the short transverse streets located on steep hillsides Colfax (Fig 128), Washington, and Arlington, Oregon, are typical examples of such "shoestring" towns Some towns fronting on railroads also have an elongated business street fronting the tracks like Wenatchee, Washington, and Shoshone, Blackfoot, and other towns in the Snake River Valley Lewiston, Idaho, and The Dalles, Oregon, have developed similar characteristics from facing a navigable river Most of these towns have few industries other than those which render service to the surrounding farmers Flour mills are fairly common, and creameries and pea canneries are sometimes seen. General manufacturing is

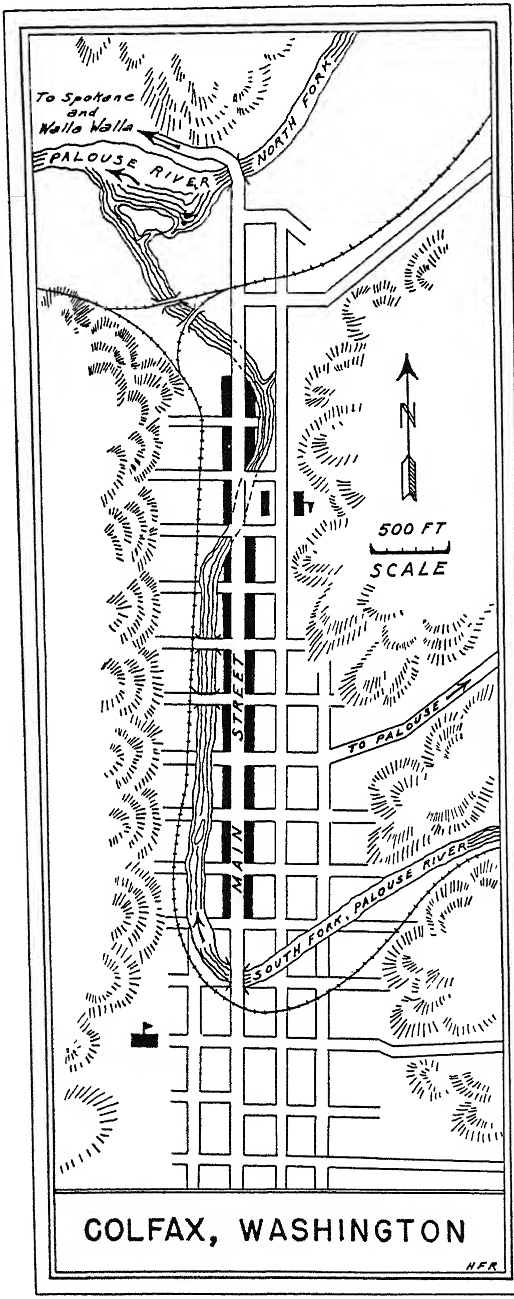

FIG. 128. Plan of Colfax, Washington, a "shoestring" town in a narrow valley

seldom found, although locally such plants exist, for example at Cheney, where farm tillage implements are fabricated

In agricultural centers the business section is usually disproportionately large for the population of the town itself, since it is supported by the surrounding country more than by its local residents. Farm-supply centers of a thousand people may have as large a business section as a sawmill town three times its size, because of difference in numbers of residents on surrounding farms Colfax, Pullman, Ritzville, Davenport, Dayton, and Waterville in Washington are among dozens of supply centers in the cash-grain district of that state. Heppner and Pendleton, in Oregon, and Moscow, Idaho, and Plains, in Montana, are other examples

If the geographical conditions are unsatisfactory for grain farming, abandoned supply towns occasionally provide "ghost towns" of purely agricultural ori-

gin, as at Stauffer and Lake, Oregon, where the surrounding country could not support homesteads with a family on every half section of land because of drouth.[2]

Fruit Centers. Throughout most of the Northwest, the towns whose principal interests are directed toward horticulture offer sharp contrasts to the "wheat towns." The cultivation of apple orchards, or patches of small fruits, is more intensive than that of the grain crops Landholdings are smaller in size. East of the Cascades, the farms range from ten to forty acres in extent in the irrigated districts, with supply centers at intervals of five to ten miles. In the fruit sections, the packing houses and fruit-shipping sheds stretch for some distance along the railroad line (Fig. 129). The towns merge with the surrounding cultivated land, so that it is difficult to distinguish the town house with its home orchard from the fruit farm with its modern farmhouse. This condition is in sharp contrast to the farm-supply town in the wheat and ranch districts, where there is a line of demarcation between the town limits and the surrounding grain fields or pastures.

In the irrigated areas, there is probably one especially important town or city every fifty or one hundred miles Here are the wholesale plants to supply the stores in the smaller outlying districts Wenatchee, Yakima, and Walla Walla in Washington, Boise and Nampa in Idaho, and The Dalles, Oregon, are examples of these larger centers Missoula, near the confluence of the Bitterroot, Clark Fork, and Blackfoot rivers, in a former lake plain, is an agricultural center of this type, centrally situated in the Rocky Mountains. The stream valleys make Missoula a true crossroads city; in fact, it was through this locality that much of the mountain region was made accessible in earlier years.

Cashmere, Prosser, Toppenish, and Kennewick in Washington, Milton-Freewater and Hood River in Oregon, Payette, Weiser, and Caldwell in southern Idaho, and Hamilton, Montana, are representative towns of a few thousand inhabitants which serve as local fruit centers. The larger towns in these sections are usually marked by the presence of such industries as box factories, breweries, and canning, preserving, and fruit-drying establishments. Among these types of manufactures, flour mills and sawmills are occasionally found.

In the central and eastern Snake River Valley, climatic conditions are unsuited to fruit growing, but the general characteristics of the supply centers in these irrigated districts devoted to potatoes and sugar

[2] For further description of farm abandonment and town abandonment in this region of eastern Oregon, see Chapter 8 of the *Pioneer Fringe*, by Isaiah Bowman

beets resemble those described for horticultural centers. Idaho Falls, Pocatello, Rexburg, Gooding, Burley, Buhl, and Twin Falls are typical examples in Idaho. Bend, Klamath Falls, Prineville, and Redmond, in Oregon, and Kalispell, in Montana, are in part supply centers in irrigated districts in other states.

FIG. 129. Fruit row at Yakima from the air. (*Photograph by Yakima Chamber of Commerce.*)

West of the mountains, where extensive irrigation of orchards and berry patches is unnecessary, the small-fruit- and vegetable-growing towns resemble the towns of the irrigated sections, although the hills covered with native evergreen foliage that adjoin the western towns provide more attractive surroundings than the unirrigated sagebrush country of the interior. The types of industries, however, are much the same in both places, with the fruit-packing plants, canneries, and associated industries. Puyallup, Washington, and Medford, Oregon, exemplify towns whose interests are related to fruit, the former being concerned with small fruits and the latter with pears and other orchard fruits.

Miscellaneous Farm Centers. Some few towns have agricultural spe-

cialties that lie outside the preceding categories of grain or fruit. The little town of Tule Lake, California, is especially devoted to the production of potatoes, and thence northward in Oregon the earth-covered potato-storage cellars, sometimes a city block in length, are very conspicuous. Almost no cultivation except potato fields can be seen anywhere in this district. Idaho Falls is famous for its potato production, and it is also headquarters for tourist travel to Yellowstone and Grand Teton national parks. It serves as a center for cattle and sheep raising and mining. Still another example of a town with an agricultural specialty is Nyssa, Oregon, which serves a wide area producing sugar beets.

In the grazing sections of the Northwest, with their cattle and sheep ranches, the supply towns are widely scattered in comparison with the wheat centers and fruit centers, since cattle and sheep ranches are usually large in extent, some of them cover thousands of acres, compared to the hundreds of acres in wheat and the tens of acres in irrigated fruit lands. A hundred miles or more may separate the larger ranch-supply towns. Dillon, Montana, Lakeview, Burns, and Pendleton, Oregon, Mountain Home, Idaho, and, in part, Ellensburg, Washington, are typical of such settlements.

The stores in these towns are usually substantially built. Stock-shipping yards are located along the rail line, and, because of the distance from competing cities, a disproportionate number of specialty stores and professional and educational services are found. The appearance of the smaller ranch-supply town, however, is not altogether pleasing. Many of them are in the semiarid regions, they are usually lacking in ornamental vegetation, and excessive dust, low one-story unpretentious buildings, and a general effect of barrenness or harshness are displeasing.

Among the recognized dairy towns are Tillamook, Oregon, and Mount Vernon, Washington. Such dairy centers are distinguished by their numerous creameries, milk-condensing plants, and cheese factories. Wholesale houses deal in the sale of concentrated cattle feed, and the community fair emphasizes the importance of dairy stock in the neighborhood.

The Nonspecialized Cities. Occasionally agricultural centers or trading centers become of such importance that their services are indispensable to the surrounding countryside. They are not centers of specialty production but of a wide variety of products, and they combine the functions of the farm-trade center, ranch-supply town, and transportation center. These settlements are characteristic of the de-

velopment which has taken place on the Snake River Plain, where the construction of dams for irrigation, the presence of waterfalls, or the convergence of routes provides a satisfactory site. Idaho Falls, with its varied activities, and Boise, the state capital, are examples of such centers, as well as Twin Falls and Burley. Twin Falls, helped by fertile

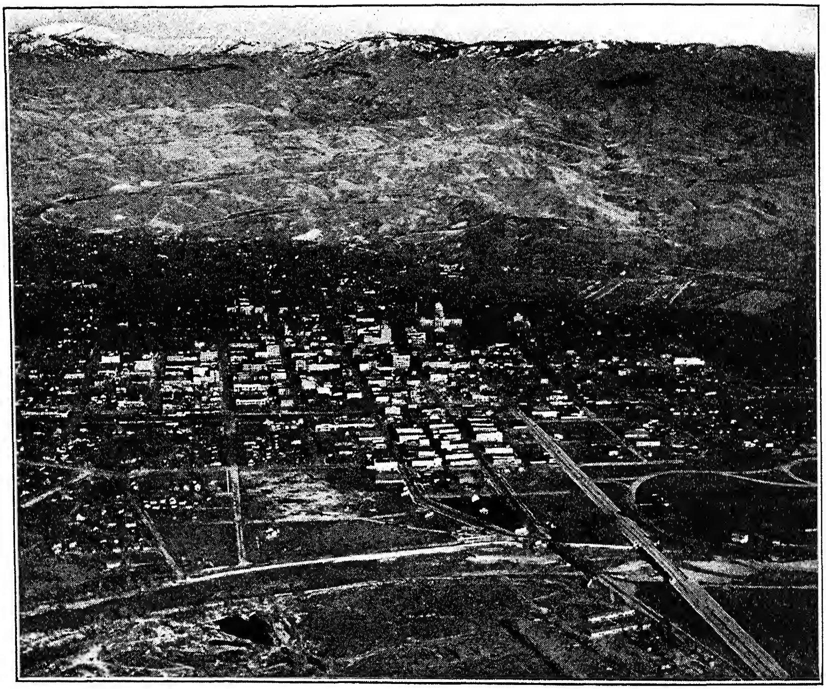

FIG. 130. Boise from the air, looking northeast. (*Photograph by 41st Div. Aviation, Washington National Guard.*)

irrigated land, has grown in the short space of twenty-five or thirty years from a mere hamlet to a prosperous city of over ten thousand. Salmon City, situated in the northeastern section of Idaho, at the confluence of two rivers, on the principal highway leading from Missoula, serves as a center of activity for a wide mountain region. Mining, lumbering and recreational activities, cattle raising and ranching maintain it. At the junction of the Clearwater and Snake rivers are the twin cities of Lewiston, Idaho, and Clarkston, Washington, where a combination of wheat, orchards, livestock, travel, and lumber enterprises occupies their inhabitants. Kalispell and Polson, Montana, are other examples of nonspecialized cities.

THE MINING SETTLEMENTS

The Northwest has wide variety of mineral deposits, and many communities have benefited from the mining industry. Most of the settlements whose activities depend upon mining are small in size, but none the less important. They are located in the mountain areas, although some of the larger centers are so situated that they command the easiest routes to the mines. The mining towns fall roughly into two groups: those which are concerned with the extraction of minerals or ores and those which are dependent upon processing and shipment of the ores. Some of the towns, of course, carry on both mining and processing. Some do neither, but rely for their income upon the furnishing of supplies to miners and mine operators Sometimes a single city may include all three functions; at other times it may be important for but one.

Butte. The largest city in the Americas whose principal industry is the extraction of metallic ores is Butte, where a single company dominates production It is located in the heart of the Rocky Mountains, so that it may be reached only by crossing the continental divide from the north, east, or south The city occupies the lower slopes of a mountain underlain with veins of copper, zinc, silver, manganese, and other metals. It is the largest city in the state of Montana, and, with its surrounding satellite mining towns and suburbs, it constitutes an urban agglomeration of about sixty thousand people (Fig 131) Part of Butte is substantially built, but in some places mining shafts, dumpheaps, shacks for living quarters, business blocks, and modern residences are scattered haphazardly in a manner common to many mining communities which grow without municipal planning.

The large amount of freight furnished by the ores of the Butte district and the supplies shipped to the city have required the construction of four transcontinental railroads through the town, as well as an ore-carrying rail line from Butte to near-by Anaconda, the concentrate-smelting center. Thus Butte, although close to the continental divide, is the principal rail center of the state and because of the ease with which goods can be distributed, it has become an important wholesale point. The main industry, however, is mining, and this has been the case since the first discoveries of mineral ores were made in 1875 Heap burning of sulfide ores destroyed trees and other vegetation for miles around the city, so that its present appearance to the casual visitor is that of an exceedingly barren town perched on an exposed hill slope; but now there are no smelters in Butte and its air is free of polluting fumes.

The railroad tracks in Butte approach the mine shafts by zigzag routes, and take the ores to Anaconda and Great Falls for reduction. The ground under the town is honeycombed with mine workings and

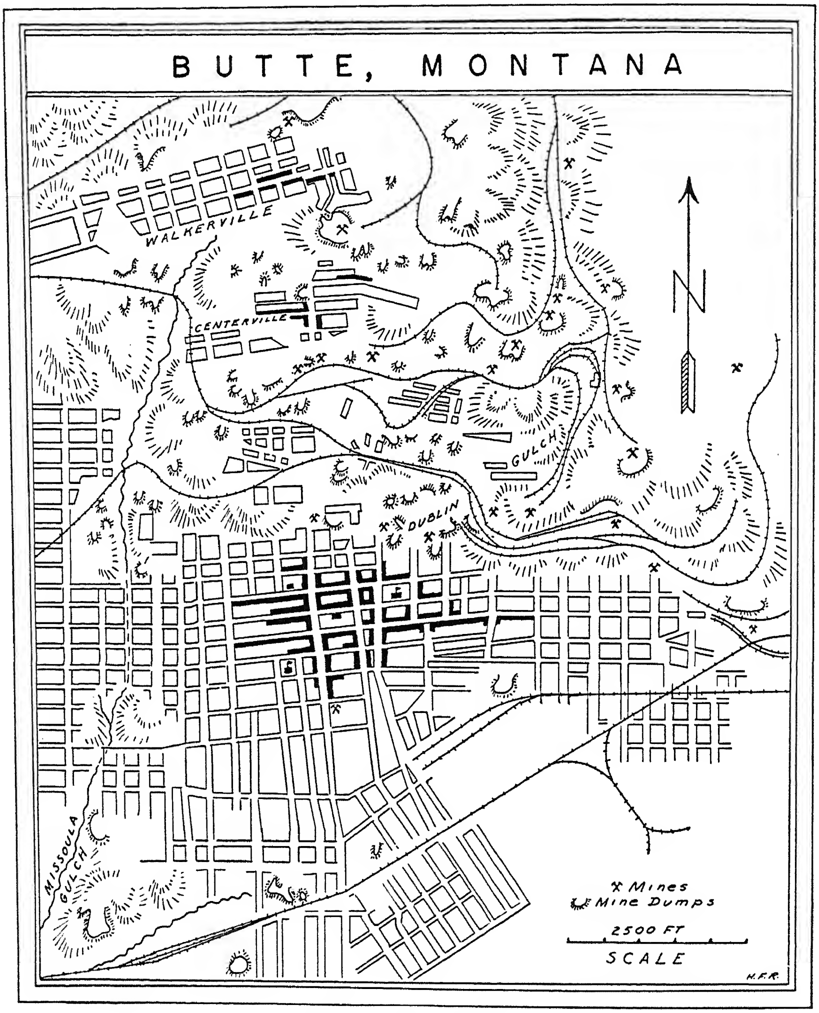

FIG. 131. Plan of Butte.

mine dumps, and "headframes" dot the landscape. The enormous mineral wealth has brought other industries and businesses to the city. The Butte mines and their associated ore-reduction properties

elsewhere are large consumers of power, and, to meet this demand, power plants have been built on the upper Missouri River Coal mines, lumber mills, and quarries, to produce flux materials, have developed from the demands of the Butte mines.

Other Metal-Mining Towns Elsewhere in the Northwest, smaller towns whose interests are principally in the extraction of ores are found in northern Idaho, where the mining towns of the Coeur d'Alene district, Wallace, Mullan, and Burke, have been active for many years and their mines are still finding paying ore at some depth Wallace is situated in a valley which is sufficiently broad to provide space for the town, but Burke occupies a canyon so constricted that a single street, menaced at times by snow slides, suffices for most of the buildings Other mining towns include Phillipsburg in southwestern Montana, Neihart in the Little Belt Mountains of central Montana, Canyon City in the Blue Mountains, Index and Metaline, Washington A recent addition to the list of towns devoted to mining is Holden, near upper Lake Chelan, where a new town site, planned by the mining company, provides for its many employees. In Canada, Kimberley, with its zinc mines, and the old mining center of Rossland are good examples.

Coal Towns. Other towns occupied with extractive industry are those near coal veins They are usually located in the foothills rather than in the heart of the mountain area itself. The advantage of the foothill location is that the coal outcrop is near the surface, whereas, in the lowlands, the veins can be reached only by a deep shaft, which would increase the mining costs. Carbonado and Black Diamond, west of the Cascades, and Roslyn and Cle Elum, east of the mountains, are types of coal towns in Washington Similar settlements, such as Nanaimo on Vancouver Island, and those found along the lines of the Canadian Pacific as it crosses the Rocky Mountains, dot the Northwest. These towns sometimes seem undesirable for residence because of smoldering waste dumps that give off unpleasant fumes of sulphur Mine structures and loading facilities on the railroad detract from the appearance of the landscape Few coal mines have been developed in places where truck transportation alone is available, because the product is too bulky for transport for considerable distances by other means than railroads. The houses of these settlements are usually of inferior quality compared to those of the more progressive agricultural supply centers. Business districts are only moderate in size, since the market consists almost entirely of the local mining population.

Reduction Centers. Although mines must be located where the minerals are found, the reduction works may be at more convenient sites some distance away. At Anaconda, the ores from the Butte district are concentrated and smelted. Many by-products are made from the ore, including sulphuric acid, explosives, and fertilizers. Great Falls is the site of another smelter which uses ore from Butte, since the former city has abundant near-by power. It was selected for the site of an electrolytic copper refinery and a plant for the recovery of zinc from complex ores by electrolysis. The smelter at Tacoma has a deep-water location making it easy to receive ore by water, and railroads bring concentrates from Holden and other northwestern producers. Since a smelter operating on the ores of many mines is more permanent than one whose ore supply ceases when its lone mine is exhausted, the Tacoma smelter is in a favorable position. Kellogg, in northern Idaho, was chosen for the site of the smelter operations in the Coeur d'Alene district. Near by is an electrolytic zinc plant. In British Columbia, Trail (Fig. 61) is the largest smelting center, and is discussed in the chapter on mineral resources.

A few towns have been built near plants which process cement-rock products. In towns such as Concrete and Grotto, Washington, and Lime, in eastern Oregon, the cement plant dominates the landscape, and the houses are clustered around the mill which provides the reason for the town's existence. In recent years, because of the increase in the supplies of water power from the Columbia River projects, the city of Vancouver, Washington, has become a center for the processing of aluminum ores which are brought first from Dutch and British Guiana to Mobile for partial processing. The resulting concentrate is then sent by boat or overland by rail to Vancouver.

Ghost Towns. Mining towns are notoriously short lived, especially those founded at placer workings. Only the piles of washed gravel and the foundations of a few buildings remain after the minerals are exhausted. A few old placer towns like Helena, Montana, and Canyon City, Oregon, may have other industries to support them after the placers are gone, but usually such centers function for only a few years. Other ghost towns are found where good showings of ore did not persist in depth, or in a mining community where once-productive mines were worked out. Altyn, in what is now Glacier Park, and dozens of similar communities in the Idaho mountains are examples. Sometimes the old mines are reopened when new ore discoveries are made, or a new process permits the recovery of paying quantities of the min-

eral. Cornucopia, in the Wallowa Mountains, now the site of the largest gold mine in Oregon, is a good example of the type. Sometimes a few prospectors remain after most of the people have gone Maiden, Kendall, and Giltedge in central Montana were abandoned for many years, but efforts to reopen mines there are now being made.

Mountain Supply Centers. In some northwestern settlements, activity is concerned indirectly with mining operations, since the miners and lumbermen must be supplied with equipment and food. These mountain supply centers are found at the junctions of valleys, centers of basins, or entrances to passes, where there is greatest concentration of population Trading, like water, gravitates down hill to these supply centers In general, the larger the valley, the larger the supply center to be found therein. The valley floor itself may be devoted to farming and dairying, with cattle and sheep ranches on the foothill slopes In addition, lumbering and mining may support good-sized payrolls. Recreation, such as fishing, hunting, or camping, is a growing source of income. If the town lies along a main road, the money spent by tourists may amount to half of the local trade. Some of these mountain towns are county seats, headquarters for the Forest Service, railroad division points, or sites of some institution. Good examples of mountain-supply centers would include Missoula, Kalispell, Libby, Hamilton, and Deer Lodge, Montana; Nelson, British Columbia; Baker, La Grande, and Enterprise in northeastern Oregon, and Grants Pass in southwestern Oregon. Leavenworth, at the head of Wenatchee Valley, and Enumclaw, near Mount Rainier, should be included in the list.

THE TRANSPORTATION CENTERS

No easily accessible and extensive plains surround the port cities of the Northwest, instead, the western escarpments of the Cascades descend abruptly to the Puget Sound-Willamette trough. For this reason, transportation lines to tap the intermountain part of their hinterlands are particularly important to these cities, and the railroads possess a pre-eminent importance, although in earlier years stream navigation was carried on where possible. The oldest towns related to transportation are those found along the rivers, especially on the banks of the Columbia, at points of embarkation or interruptions in stream traffic.

River Ports. Until the construction of the railroads, bulky commodities were brought upstream from Portland and distributed from the river landings. The Dalles, Lewiston, Wallula, Almota, and other

landings on the Columbia and Snake rivers were used Since these streams usually flow in incised channels or gorges, the principal requirement for a steamboat landing was accessibility, usually by way of valleys leading back to the hinterland Goods were also brought up to Fort Benton at the head of navigation on the Missouri River for supplying the mines of southwestern Montana and westward. After the construction of the rail lines, river ports declined in importance except as they became useful in other ways, as The Dalles and Lewiston. The building of locks and canals, mentioned in Chapter 22, resulted in great increase in the use of waterways, to the advantage of the towns of Umatilla, Wallula, Pasco, The Dalles, and Lewiston. There are good prospects for future shipments of petroleum by the water routes, and exports of wheat, wool, and other produce, to the eventual advantage of such towns.

A typical river town on the Columbia had its business section facing the river, but, after the arrival of the railroads, the river-front stores and warehouses deteriorated and the business district moved away from the river, while the warehouses and factories were moved to positions along the railroad. This tendency can be observed at The Dalles and Lewiston, and a somewhat similar situation prevails at Portland. Rejuvenation of river traffic may reverse this tendency.

Railroad Towns. Railroad construction in many parts of the Northwest preceded settlement. At convenient intervals the railroads established division points, junctions of branch lines, and repair shops Car shops were located at greater distances, usually at some main combined division and junction point or terminal. In some Northwest towns, the principal income has always been derived from the rail lines. Pasco, Washington, Huntington, Oregon, Whitefish, Montana, and Pocatello, Idaho (Fig 132), are "railroad towns," although, in Pocatello, other industries have brought diversification because its crossroads position at the intersection of the Oregon Trail and the north-south route to Salt Lake City gave it an early trade advantage. These rail towns have extensive yards where freight cars are handled and trains made up Round houses, car shops, supply depots, stock yards, and icing plants are characteristic adjuncts. Close by the yards are rooming houses and eating places for the use of the train crews and other employees. In many instances, especially in smaller towns, the business section faces the railroad in one long street with all the stores on one side of the highway, presenting a curious contrast to the type of town development at the intersection of two equally important highways.

Increasing size of locomotives and other improvements in transpor-

tation allow the railroads to lengthen the distance between division points. As a result, once-important towns such as Malden, on the Milwaukee line, may be nearly abandoned. Formerly, rail lines between Seattle and Spokane operated on three divisions. Division points on the

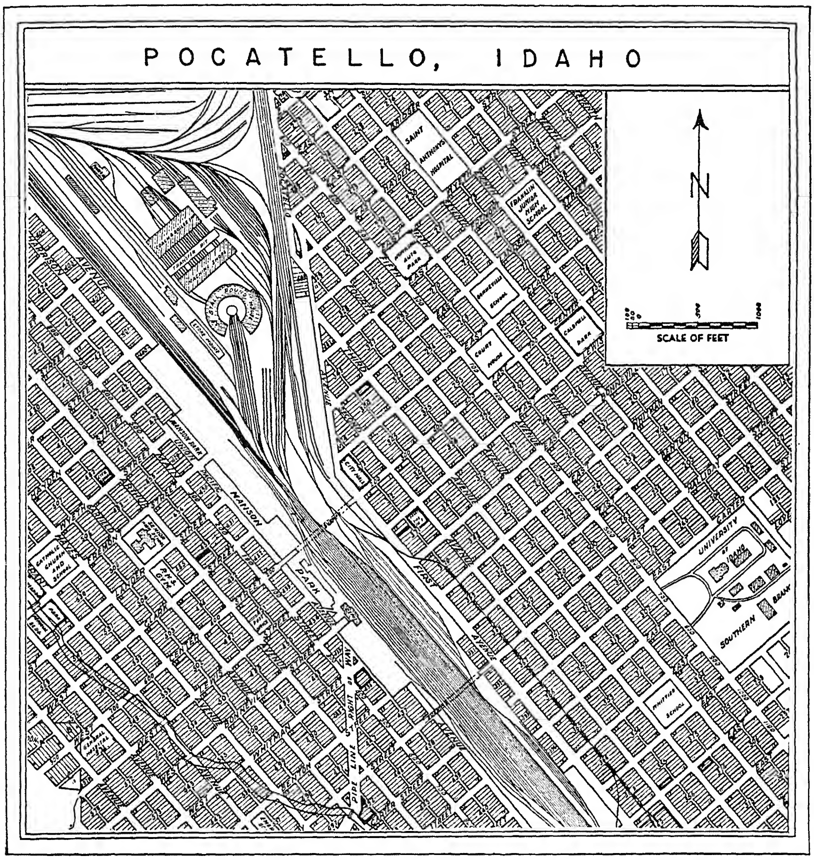

FIG. 132. Plan of Pocatello.

Northern Pacific were at Ellensburg and Pasco; but now this line operates on two divisions, with locomotive and train crews changing at Yakima.

Spokane

One of the northwestern cities, Spokane, owes much of its importance to the railroads which serve it. It is the largest intermountain city in the Northwest, located at the northeastern corner of the Colum-

bia Plateau, near the Rocky Mountains. The city (Fig. 133) occupies both banks of the Spokane River, which is deeply incised in the plateau surface below the falls. Growth of the city to the west of the falls was greatly impeded for many years by the walls of this gorge and by the presence of a military post and cemeteries. However, by building bridges and new roads this handicap has been largely overcome. The city, originally known as Spokane Falls, was permanently settled in 1873, when the falls were first used in sawing lumber and grinding wheat. They have aided the growth of the city ever since, although at present most of the power is used for generating electricity. The city consumes much more power than these falls can supply, so four other generating plants were built, both upstream and downstream, from which additional power is transmitted for urban use. The largest of these is at Long Lake, where the river cuts through a narrow granite gorge.

During the glacial period, extensive gravel terraces were deposited in the Spokane River valley These now serve as convenient level tracts for building purposes. South of the city, the rimrock of lava approaches the river and interferes with orderly street planning, although its rocky slopes and hilltop have been developed into a desirable residential district. On the north side, the slope is so steep that it interferes with construction and therefore remains largely unoccupied. Except for minor variations, the pattern of the city is a combination of square- and gridiron-shaped blocks, with two main diagonal avenues.

Railroads enter Spokane from the east by way of Spokane River valley, and leave the city in a west or southwesterly direction over long high bridges across the Spokane gorge below the falls. In all, five transcontinental and twelve branch lines radiate from the city, making it the greatest railroad center in the northern United States between the Twin Cities and the Cascades.

The convenience of transportation naturally favored the location in Spokane of jobbing and wholesale establishments, and improved highways supplemented the railroads, encouraging buyers and visitors to come to Spokane from every direction. As a result, the city sells goods at retail to people who come from longer distances than is customary in the East and Middle West. With a population of over 125,000, it is both the wholesale and retail center of the Inland Empire, which is the expression in common use for the entire intermountain country between the Cascades and the continental divide of the Rockies, from northeastern Oregon on the south and the Canadian border on the

north. The numerous stores cannot all be supported by local residents of Spokane, but they depend largely on the wide extent of the city's hinterland.

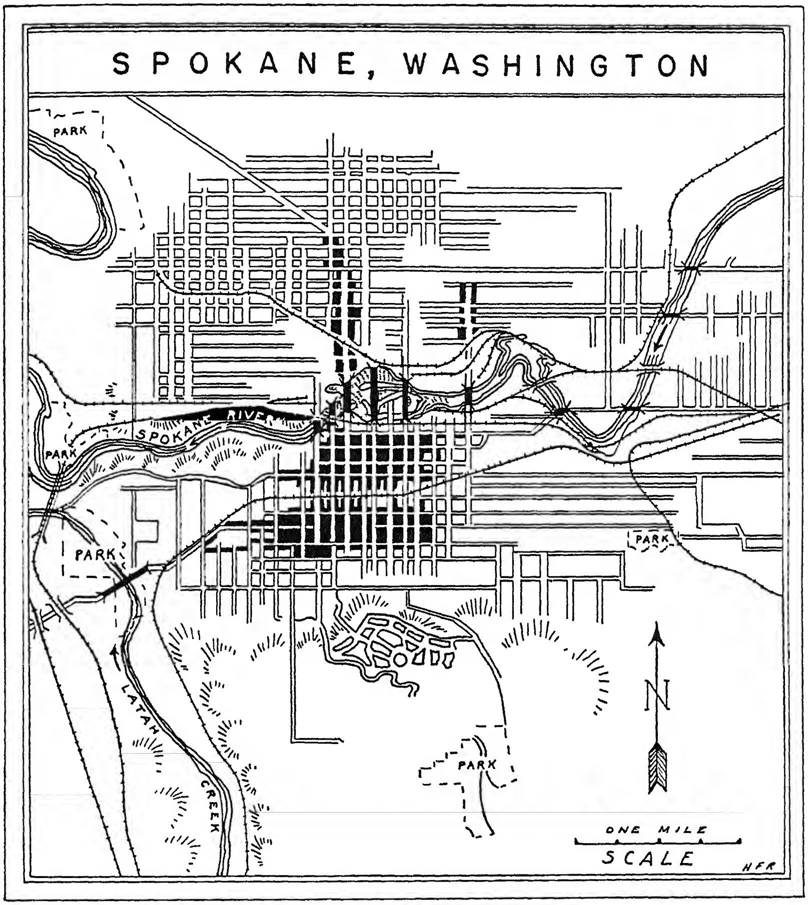

FIG. 133 Plan of Spokane

Spokane is more important as a distributor of goods than as a manufacturer. Industrial plants, however, line the river east of the falls, and include sawmills, woodworking establishments, and flour mills. Printing and publishing houses, creameries, breweries, many bakeries, and other industries are prominent, as well as large iron works and railroad car shops. East of the city limits there are meat-packing plants, several

woodworking mills, a paper mill, a cement mill, and fruit- and vegetable-processing plants.

The growth of Spokane is the result of a combination of natural and human factors. The natural factors include the presence of water power, a pass to the eastward over the northern Rockies, a convenient location for the distribution of farm commodities, and ready access to lumbering, stock raising, and mining areas. The human factors include the selection of Spokane as a terminal and division point by railroads which helped the city to become an important wholesale and distributing center. Its resources of minerals, lumber, and agricultural produce have favored manufacturing but not to the same extent in proportion to population as in the coastal cities of the Northwest. Many of the large business blocks of Spokane are monuments to profits from the mines of northern Idaho and southern British Columbia.

Construction Centers. During the construction of railroads throughout the Northwest, temporary centers were established at rail heads which moved forward as construction proceeded. The "ghost town" of St Regis, Montana, is a relic of this activity Near tunnel entrances, the settlements had a more permanent status because of the longer duration of construction work. Tye, at the western end of the old Great Northern tunnel through the Cascades, once had a population of several hundred, but now it is difficult to find the location of the place, because its buildings were burned when the tunnel was completed. Rock Island had a population of more than two thousand during the building of the dam across the Columbia River. When it was finished, a few workmen sufficed to operate the dam machinery, only a few dozen people remain there. Unless new industries develop, most of the 15,000 inhabitants of the Coulee Dam site can be expected to leave after construction is finished.

New Transport Types. Two types of settlements, associated with transport, are beginning to make their appearance, but as yet they have not become sufficiently distinctive to be placed in separate categories. The first, just evolving along the major highways, is actively concerned with truck and tourist traffic, and exists by reason of its small restaurants, garage service, fuel-supply stations, and automobile court facilities. It is too soon to tell what form it may take, but it cannot be classed with supply centers, rail centers, and the like. It promises to develop into a distinctive feature of the landscape. The other future settlement site may develop near airports, providing services and housing for airport employees and repair shops.

TABLE 35

POPULATION OF MAJOR CITIES IN THE PACIFIC NORTHWEST

Year	Seattle	Portland	Vancouver, B C	Spokane	Tacoma
1870	1,107	8,293			
1880	3,533	17,577	297 (1883)	350	1,098
1890	42,837	46,385	13,432 (1891)	19,922	36,006
1900	80,671	90,426	29,432 (1901)	36,848	37,714
1910	237,194	207,214	120,847 (1911)	104,402	83,743
1920	317,312	258,288	163,220 (1921)	104,437	96,975
1930	365,583	301,815	246,593 (1931)	115,514	106,817
1940	368,302	307,572	275,000 (estimated)	122,001	109,408

THE PORT CITIES

Seattle[3]

Environmentally speaking, Seattle is one of the most highly water-conditioned and water-conscious cities in America Like its larger sister ports, New York and San Francisco, metropolitan Seattle is almost entirely surrounded by water. At its commercial front door is an arm of Puget Sound, Elliott Bay, with ample anchorage and miles of wharf and dock frontage. In its urban midsection is Lake Union, now completely ringed with industrial plants using or making water-borne materials. At its residential rear is lovely Lake Washington, twenty-six miles long and rimmed with homes. To unite the three, Lakes Union and Washington were joined by a short navigable channel to give their waters a common level, and a canal with locks was cut from Lake Union to Salmon Bay on the Sound. The great Ballard locks with a lift of twenty-six feet at low tide provide easy marine access to Lake Union, which ocean freighters frequently use as a fresh-water anchorage. Fishing vessels, pleasure craft, and tugs with barges or log rafts can move freely between Puget waters and the lakes, the North Pacific whaling fleet, for example, winters at Bellevue on the east shore of Lake Washington In South Seattle, part of the lower Duwamish River has also been dredged to ocean-going depth Lakes, canals, bays, and the Sound itself form one vast interlinked system which gives Seattle optimum flexibility in water haulage

Loosely sprawled between Lake Washington and the Sound (Fig. 134), the city is built on a series of hills or roughly parallel north-south ridges composed of glacial detritus. With one eye on classical

[3] The section on Seattle was contributed by Howard H Martin.

Rome, Seattle usually refers to its seven hills The number is actually indeterminate, and the hills themselves are irregular jumbled masses, including many steep ridges of unconsolidated gravels At best they provide a difficult base on which to work out any major urban adjustment. So, in addition to water, Seattle is also hill-conditioned and hill-conscious.

The first settlement inside present urban Seattle was made at Alki Point in 1851. It proved to be a poor location for a village needing a good harbor. The following year settlers moved across Elliott Bay, clustering around the Yesler sawmill at the foot of what is now Yesler Way, which became the center around which the new town gradually took shape. The bay plain at this point was narrow, Yesler Hill ascending steeply to the east. As the village logged off its fir and cedar, there were two possible directions for expansion; first, the flat and swampy plain which widened gradually southward to the Duwamish flats, and, second, a moderately steep slope northwestward along the shore of Elliott Bay. The immediate waterfront offered level land for little more than one or two streets The growing town turned its back on the swamps and took the steeper path, first residences, then the business blocks ascended northward until, decades later, they were to be stopped by Denny Hill.

Today the central business district of Seattle begins at Yesler Way near the waterfront, rising steadily northward some eighteen blocks in a fairly compact oblong About five blocks wide at the southern end, it broadens to eight or ten after the flatter hilltop is attained.

Residential Seattle early sought the high ridges and hilltops. Discriminating citizens selected pleasing sites with vistas of mountain, lake, or Sound. Construction of homes proceeded up Yesler Hill, went over the top, moved unsteadily across the uneven logged-off ridges, and in time reached the escarpment overlooking Lake Washington. The less desirable tracts between view ridges were left as gaps in the settlement pattern. Some additions were made by absorption. Ballard, a busy fishing and sawmill town fronting on Salmon Bay, was added in 1907, West Seattle, with its Alki Point pioneer marker, came in the same year. Industrial Georgetown and blue-stocking Laurelhurst were admitted in 1910 Unlike many other western cities, however, Seattle is conservative about absorbing adjoining suburbs and has made no new additions to its urban area in the past thirty years.

It was fortunate that the early town chose the highland for its business district and ignored the lowlands. The railroads, arriving in

the eighties, followed the narrow valleys and spread out their terminals and yards on the almost unused flats. By skirting Elliott Bay and following other flats between glacial ridges, later lines from the north found equally easy routes. All the railroads use the narrow waterfront.

FIG. 134. Plan of Seattle.

Railroad Avenue is hemmed in tightly between the hills and the Bay, but it offers the maximum of efficiency in linking rail and water routes. Short curved spur tracks onto each wharf bring freight cars directly alongside freighters and ferries.

During nearly half a century of moderate growth, Seattle was one of three or even four towns of relative mediocrity on Puget Sound. Portland on the Willamette had the only claim to urbanity in the entire Northwest. Then on July 17, 1897, a steamer from Alaska ar-

rived with the discovery shipment of gold The following year the Klondike rush began. Seattle was the recognized gateway and secured the cream of the outfitting business. The exact value of Alaska to the striving port on Elliott Bay will always remain a question, but the stimulus was undeniable. Seattle and Alaska were linked together in the public mind, a fact of no small advertising value Between 1898 and 1910 Seattle had its period of greatest growth, changing from a muddy sawmill and lumber-shipping town to a recognized urban center in the short space of twelve years (Table 35) Many years later the city was to acknowledge its gratitude Dressed up with a new seawall and with its hodge-podge of frayed piling-and-plank roadway replaced by concrete paving, old Railroad Avenue, busiest freight thoroughfare in the Northwest, is now officially Alaskan Way.

Just as New York is forever tearing down buildings and erecting new ones, Seattle is forever regrading its hills. In the early 1900's, finding that certain glacial ridges were standing in the way of progress, the city washed them down with hydraulic mining equipment, sluicing the mud and gravel out into the Sound. Later, the Jackson Street project leveled the side of another large hill. Denny Hill stood squarely in the way of any further expansion of the business district, so in 1929 it was attacked with electric shovels, a moving conveyor belt, and scows which carried the dirt out into the Bay for dumping Completed in 1931, the Denny regrade added thirty-seven square blocks of level surface to the building area Seattle has completed more than sixty regrade projects in the past forty years, and over fifty million tons of earth have been sluiced into Elliott Bay or used to fill low mud flats. It is doubtful if any other city in the country has moved so much dirt.

The terrain has affected the city pattern in other ways For many years selective settlement was the practice, and streets were laid out with little reference to any urban plan. Some areas were plotted in one direction, some in another. Gradually all these scattered residential islands have been brought together. The resulting angular unconformities have created some transportation difficulties, but give a not unpleasing variety to the city pattern. Even today much of Seattle is unco-ordinated, with many unbuilt gaps Scattered expansion of this type has made the cost of city services, including light, sewers, streetcar lines, busses, somewhat more expensive than in more compactly built urban centers.

Access to the area across Puget Sound has also made Seattle, like New York and San Francisco, a city of ferry communication A score of

services carry commuters to Bainbridge or Vashon islands as well as to a number of towns along the Olympic Peninsula. Many hundreds of Bremerton navy yard workers who live in Seattle jam the ferries night and morning Until 1939 several ferries also crossed Lake Washington to the suburban residential centers on the east side. A floating bridge of concrete pontoons now spans Lake Washington and gives a better outlet to the east, eliminating some of the ferries.

The industrial character of Seattle is not particularly well defined, but three main types of manufacturing tend to give the city a certain amount of industrial personality The woodworking group lists, among others, lumber, sash and door plants, a shingle industry, and a steadily increasing furniture industry. The mechanical group includes marine engineering and its allied crafts such as woodworking machinery, ship building and repairing, and the relatively new airplane plants The processing of foodstuffs includes the canning and quick-freezing of fish, fruits, and vegetables, the milling of flour, preparation of coffee, tea, and spices, and numerous bakeries. Hinterland raw materials, particularly softwoods, have been the dominant bases for manufacture. Entrepot manufacturing—the processing of commercial materials passing through Seattle—is far less than might be expected. For the future available and potential hydroelectric power is more than ample for any feasible expansion.

Factories in general are located in the south part of the city, along the lower Duwamish flats, around Lake Union, and around Salmon Bay in the Ballard district. Any location fronting on tidewater or even on the lakes may be a factory site now or later.

Seattle's largest industrial payroll is airplane manufacture, a home-grown industry less than twenty-five years old. It began in a modest way in a small shop on Lake Union, expanding with the national growth of air transportation. Now located on the Duwamish flats in south Seattle, where modern shops and huge assembly plants cover a wide acreage, it is one of the major industries of the Pacific Northwest.

The shipyards, dry-dock companies, and machine works on Elliott Bay and Lake Union build new vessels and recondition old ones. In 1941, as part of the national defense program, this industry was in process of rapid expansion including additional shipyards and ways.

In spite of Seattle's talk of new plants and industrial payrolls, the waterfront rather than the factory dominates its urban personality. It is primarily a handler of cargoes. Not satisfied with the miles of dock space along the margin of Elliott Bay proper, the city reached

out to the north, dredged new berthing space at Smith Cove, and built Piers 40 and 41, now among the world's largest ocean terminals. The *S.S. Queen Mary* and the *S.S. Normandie* could be docked end to end on one side of Pier 41 and still leave several hundred feet of extra berthing space Including Smith Cove and the deepened Duwamish in south Seattle, Elliott Bay now has over twenty miles of ocean-depth frontage.

The Seattle waterfront might well have as its theme song the whirring of winches stowing sling loads of freight, punctuated by the hoarse shout of the stevedores. In normal times over 5,000 workers of various types are employed along the waterfront and many more in allied occupations. Ships of all nations load and unload, and it is not uncommon to find all the way from a dozen to twenty-five vessels on berth simultaneously. A glance at the shipping page any week will reveal that the *San Simeon*, the *Kaimoku*, or the *Eastern Trader*, as the case may be, is

> to load a full cargo of lumber for Hawaii,
> loading general (cargo) for Alaska,
> discharging sulphur lifted at the Gulf,
> in from South America with coffee and River Plate items to let down,
> taking a full load of wheat for Vladivostok,
> coastwise carrier, stowing piling in East Waterway,
> discharging steel and east coast freight at Pier 41,
> reefer loading apples for England and Scandinavia

When Europe is at peace as many as twenty or thirty refrigerator ships, known in maritime circles as "reefers," may lift boxed fruit in the course of a single month. Timber products inevitably make up the great bulk of Seattle outbound shipments, but imports include a wide list of general cargo items coming from the East coast and Europe by way of the Panama Canal. Seattle still has an almost proprietary interest in Alaska, and several lines are concerned only with Alaska freight and passengers.

So Seattle seems likely to remain a city with a saltwater flavor, where the waterfront and its railway and shipping services are dominant, where the everlasting urge is for speed, efficiency, and cost-cutting in the handling of cargo. After a forty-year struggle to remake its physical setting, co-ordinate its waterways, and remove as many transportation bottlenecks as possible, the city on Elliott Bay is still striving to improve its access Seattle is today calling for faster rail service to Chicago and the East, bigger and speedier steamships to the Orient, and more

air lines and air fields. It even has a plan, not too daring or visionary, for a future major air route which will start here, curve up across Alaska and down to the Orient, following roughly the same Great Circle route which shortens the sailing distance across the North Pacific.

Tacoma

Tacoma is located on tidewater near the northern end of the Puget Sound Lowland, where the Puyallup River empties into Commencement Bay (Fig. 135). This southern end of the Sound proper is 142 miles from the Pacific Ocean. The entrance to Commencement Bay is over four miles wide, and the water alongshore is so deep that early settlers boasted that any ship could be moored to the trees along the bank. Today there is deep water along the entire water front. The harbor is commodious, with a minimum depth of 25 feet of water at all commercial wharves. The port district includes all of Commencement Bay, but only the southern and eastern parts have been developed as terminals. Six navigable basins have been dredged through the alluvial flats at the head of the bay, and a large potential industrial area has been created by filling in behind bulkheads

The water front and tidal flats at the river mouth, as well as the lowland district known locally as the "prairies," have been left for industrial and commercial development. The industrial districts lie almost entirely below the 50-foot contour. The lowland of the Puyallup River flood plain and the reclaimed tide flats area provide level industrial sites, largely occupied by lumber, wood products, pulp, chemical, and metal-working plants, access to all the major railroad lines is provided by a municipal belt line. A second industrial zone runs northwest along the exceedingly narrow coastal plain of the peninsula. It is largely occupied by wood-working plants and flour mills A third grouping of industries without tidewater frontage is in the narrow valley running west and then south between the heart of the city and the southern business district known as South Tacoma.

A small sawmill on the south shore of Commencement Bay was built in 1852. The settlement which grew up around it, now called "Old Tacoma," was established at a point where the coastal plain was only about 300 feet wide. Early in the 1870's the small town of 200 people was selected as the Puget Sound terminus of the Northern Pacific Railway. The terminus was located on the broad lowland at the head of the bay where there was ample room for station and yards A new town at once grew up around the station, while old Tacoma three

miles away dwindled to insignificance. Stimulated by this new connection with the East, Tacoma's population was 4,400 in 1884. During the next five years speculative enthusiasm grew, culminating in the boom of 1888-1889. Mills and factories rimmed the shore line, and

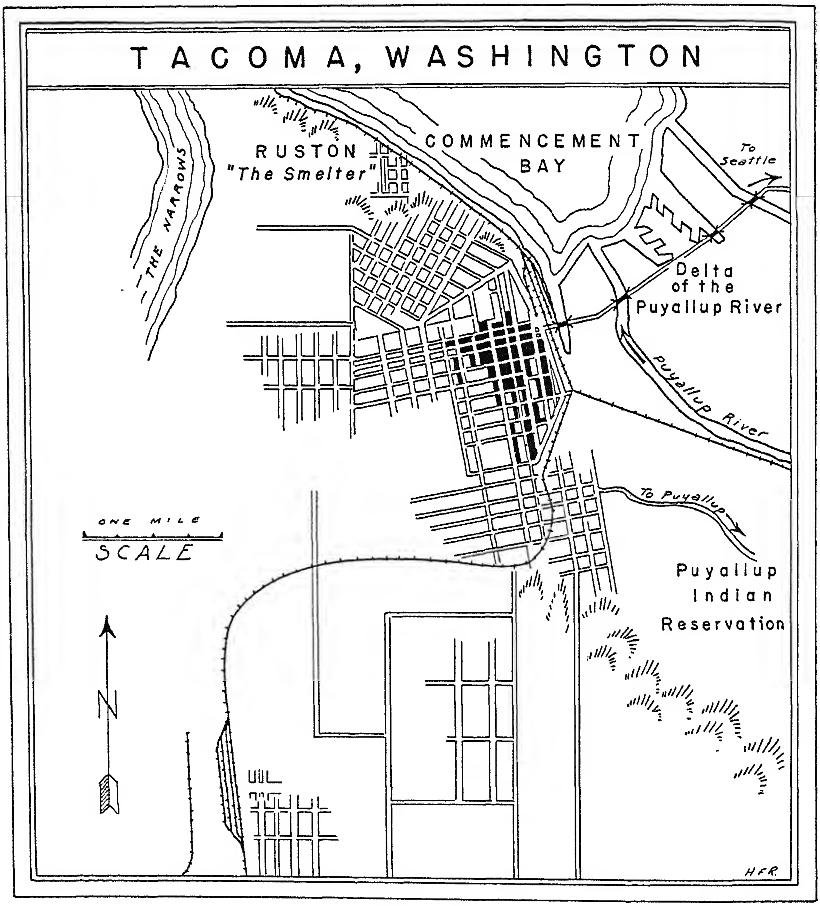

FIG. 135. Plan of Tacoma.

scattered plants were even located on the tide flats and on the so-called prairies south of town. The population jumped to 36,000 in 1890, but the boom with its attendant overexpansion collapsed in the depression of 1893. Today heavy tonnage is carried by ocean vessels and railroads are probably not as important to Tacoma as to other northwestern cities.

Before 1900, Tacoma and Seattle, with populations nearly equal, were lusty rivals for commercial leadership on Puget Sound. Seattle gradually secured better railway and ocean shipping facilities and profited directly from the Alaska gold rush, which was of minor importance to Tacoma By the end of the First World War, Tacoma had established most of her characteristic industries a wide range of wood processing in which the constant attempt was to sell more highly processed materials rather than raw lumber, flour milling, electrometallurgy, particularly refined copper; electrochemicals with their related industries, and boat and ship building. In addition to factors of tidewater location and favorable access to materials, cheapness of power has been of increasing significance A slow but steady increase in population brought the city to 110,000 in 1940

Tacoma is pre-eminently a "payroll" town. Few industries have played a more important part in the development of the city than has wood processing Since the building of the first sawmill in 1852, wood and its derivatives have continued to rank first Today 48 8 per cent of the wage earners are employed in wood-processing establishments. Although in the early days lumber and cooperage stock were the only exports, the list has expanded steadily until almost every type of wood product is now represented Many small specialty shops make such diverse things as berry crates, egg cases, churns, rolling pins, step ladders, beehives, butter molds, and fish kits. With twenty-one factories, many specializing in high-quality upholstered pieces, Tacoma is one of the principal centers of the Northwest furniture industry Two electrochemical companies have opened western branches in Tacoma for the manufacture of chlorine and caustic soda, needed by the pulp and paper industry.

One of the special industries, known locally as "The Smelter," is actually a city within a city It is officially located in Ruston, a company town, but it is completely surrounded by Tacoma, and is an integral part of the urban area Its enormous brick stack that carries away smoke and fumes is one of the features of the industrial landscape.

Tacoma now ranks fifth in the United States in flour milling, grinding more than any city west of Kansas City and Minneapolis Wheat is brought to the mills from eastern Washington, Oregon, Idaho, and Montana

A fine natural harbor, ready access to timber, demand for ships, and favorable conditions for ship building have encouraged the construction of small boats, particularly fishing boats for use in Alaskan waters. During the First World War, and again, beginning in 1940, Tacoma

yards built various types of ocean-going vessels. Ship building was further expanded in 1941.

Vigorous competition from the larger cities of Seattle, 30 miles to the north, and Portland, 150 miles to the south, together with the Cascade barrier to the east, set sharp restrictions upon the trade hinterland of Tacoma. It serves as the shopping center and wholesale distributing point for much of the farming and timber-working territory 60 miles to the south and as far west as the Pacific Ocean; but even within this area Seattle overlaps Tacoma as the main trading center.

Like Seattle, Tacoma is attempting to capitalize the natural beauties of its location. The street pattern accommodates itself to various coastal contours, as well as to numerous deep ravines which penetrate the hills. The present business and shopping district occupies the first easy slope which rises gradually from the tide flats, and the residential areas of Tacoma are on rolling hills and uplands south and west of the harbor, and along picturesque bluffs overlooking Commencement Bay. The main residential level lies away from the railroads so that visitors passing through Tacoma by train do not see this pleasant section.

Vancouver

Of the northwestern port cities, Vancouver is conspicuous because it is the largest city in British Columbia, and the western terminus of two transcontinental railway lines. The city has grown back from Burrard Inlet, and now spreads over the relatively low peninsula between the inlet and the northern arm of Fraser River (Fig. 136) Near-by New Westminster, an older city, was founded in 1859, where settlers began to dig for coal at Coal Harbour on Burrard Inlet. By 1865, three mills had been built, and a small lumber town, Granville, had sprung up at Coal Harbour It attained growth (Table 35) and importance only after the decision of railway officials to make the settlement the terminal of the Canadian Pacific Railway In 1886, Granville was renamed Vancouver. Its first transcontinental train arrived in 1887, and in 1891 steamship connections were established with the Orient.

Nearly all of Canada's trans-Pacific trade passes through Vancouver. The harbor is deep and sheltered. Seventeen piers, four oil docks, and seven grain elevators are now available for shipping Both shores of the harbor are fringed by lumber mills, flour mills, iron works, packing plants and canneries, shipyards, and a large sugar refinery. The commercial section of the city occupies a terrace about eighty feet above tide level, and the wholesale section is near the docks. The financial

and retail districts are on higher slopes. The mild weather conditions and attractive setting of the city have made Vancouver popular with tourists.

FIG. 136. Plan of Vancouver.

Stanley Park, a natural forest beauty spot with huge fir trees, adjoins the business section and occupies the point at the entrance to the harbor. From the park the towering hotels, banks, and business blocks, gleaming white against a distant background of purple mountains and green forests, present an attractive appearance (Fig. 137). By the park, move the huge "Empress" liners to begin their voyage across the Pacific, the swift "Princess" coastal steamers, the homely but utilitarian

"tramps," and the bustling ferries. As Vancouver is the chief jobbing, wholesale, retail, and financial center for the province of British Columbia its business district is larger and better built than an eastern industrial city of similar population Luxury goods, like fine glassware or porcelain, furs, jewelry, expensive clothing, and rare house furnishings are widely displayed, suggestive that both tourist and local

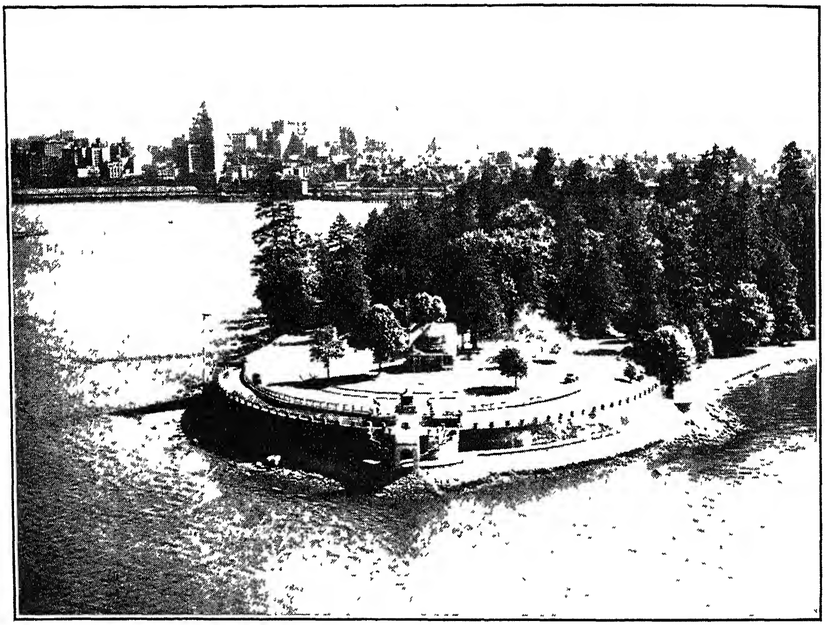

FIG. 137 Air view of Vancouver, Canada, showing city skyline and section of Stanley Park (*Royal Canadian Air Force.*)

money is spent widely at Vancouver. Large industries in the province are mostly managed from Vancouver, and together with the foreign and coastal shipping trade add to the importance of the city. Victoria seems like a "bit of Old England," but Vancouver has the bustle and vim of its friendly rival, Seattle. Tourists find the city and its mild climate attractive and also use Vancouver as a starting point for vacation trips into the scenic mountains or to hunt big game and enjoy the sport of fishing.

Victoria

The capital of British Columbia, Victoria, lies on the southeastern end of Vancouver Island, in a sheltered cove along the low and rocky

coast. The rolling farmlands and wooded hills bounding the city on the north and west, with the snow-clad Olympics in the distance, help make it attractive to tourists and residents. The site was selected for a Hudson's Bay Company fort in 1834, and it represents one of the few northwestern cities that has developed from such a post. In 1858 the rush of gold-seekers to the Cariboo country swelled the population of the town from a few hundred to more than twenty thousand within a few weeks.

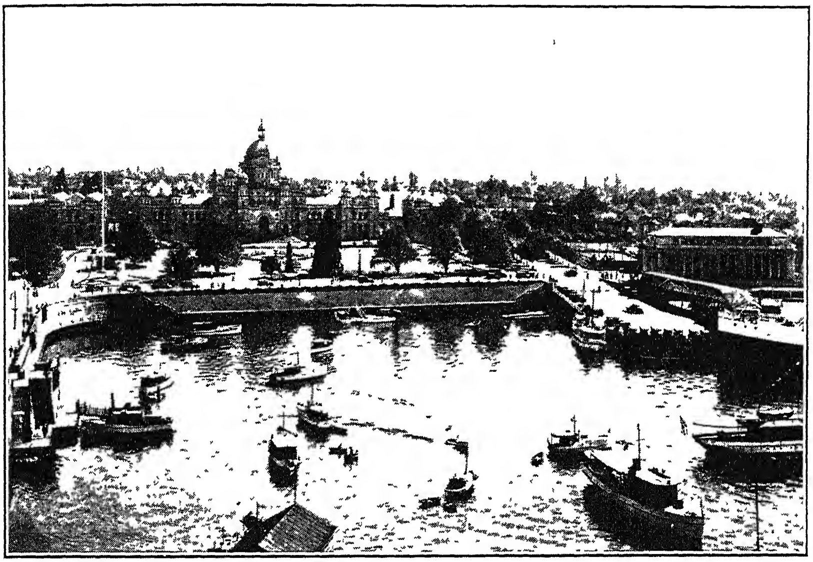

FIG 138 Inner harbor, Victoria, with Parliament buildings in the center (*Courtesy Victoria and Island Publicity Bureau*)

In 1866 Victoria was chosen as the capital of the province, and it was also the principal commercial center until 1885, when Vancouver became the railway terminus. The growth record of Victoria and Vancouver is a prime demonstration of the necessity for a rail connection in the development of a modern port, Vancouver usurped the commercial and industrial activities, whereas Victoria in its relative isolation remained the conservative cultural, political, and tourist center

Victoria has always been the urban center of Vancouver Island, the city and its immediate vicinity support over sixty thousand people. With good shelter and adequate depth in its inner and outer harbors, Victoria serves a hinterland of farms and forests. These, with the fisheries and minerals, maintain some industrial plants and provide exports such as cement, furs, small fruits, fresh and canned fish, whale oil, logs,

lumber, wood pulp, and the like. North of the inner harbor (Fig. 138) there is a small industrial section, but Victoria is more noted for her shops and her residences and her gardens which overlook the sea and, to the south, the snow-clad Olympics, which merge into a pleasing countryside to the north and west. The city is mainly administrative and residential, and its life lacks the confusion of commercial centers like Vancouver. The spacious grounds of the Legislative Building, lying south of the inner harbor, set the tone of stately and quiet beauty, which is the keynote of Victoria. Retired civil servants and military officers, many from India, have found Victoria to their liking, and have done much to recreate the atmosphere of England, even to the construction of Kentish and Essex country houses. In spite of its seeming quiet, however, the city advertises widely in the western United States, and much of its annual income is derived from tourist sources.

Portland

The intersection of the Columbia River and the Willamette Lowland provides a natural crossroads site for the city of Portland (Fig. 139). Advantages of the location have been enhanced by the construction of highways and deepening of waterways, whereas disadvantages have been overcome by construction of bridges over the Willamette River, whose banks the city occupies. The improvements, however, have been made at some expense. Portland harbor lies 110 miles from the open sea, and can be reached only after crossing a bar at the mouth of the Columbia. Originally the Willamette River was so shallow that no boats with more than ten-foot draft could reach the city. Widening of the channel to over 300 feet and dredging of the river bottom now make it possible for freighters of thirty-five foot draft to ascend the Willamette to the port, but few passenger steamers make Portland a regular stop. Jetties, completed in 1928, deepened the Columbia's channel over the troublesome entrance bar to a depth of forty-five feet. In spite of these changes, the approach to Portland by water is more dangerous than the approach to Seattle by way of Puget Sound. Three-fourths of the ocean vessels reaching the city are engaged in intercoastal trade, and hence Portland has made relatively few foreign trade contacts.

The eastern approach to the city, by way of the Columbia River gorge, is the only low-level route (97 feet altitude) through the Cascade Mountains and is followed by railways and highways on each bank. The railroads have a water grade and fairly straight road bed, but the Columbia River Highway on the south bank, while scenic, is narrow and winding, and will be supplemented by a new low-level road now

under construction. Improvements on the Columbia have materially increased river traffic east from Portland in recent years, although the city is somewhat handicapped by its location up the Willamette Railroads handle by far the greatest tonnage through the Columbia Gorge.

In spite of all her efforts to tap the country east of the Cascades, and her successful enterprise in developing a seaport, Portland's natural hinterland—the Willamette Valley with its encircling mountains—is her greater source of wealth. The climate of the valley, superior for mixed agriculture, and its soils, better than the glacial soils of the Puget Sound Lowland, provide one of the best farming sections of the Northwest. Portland profits accordingly, for this combination of advantages has made the city a wholesaling center for farm machinery and agricultural supplies. To some extent, Portland also draws upon the Puget Lowland north of the Columbia as far as Chehalis and Centralia. The city of Portland, therefore, is the dominant agricultural market and agricultural export center of the Northwest. The volume of wheat traffic is twice that of Seattle, and ranks with that of Galveston and Duluth. Half of the wheat shipped from Portland comes from Washington, and nearly half from Oregon. Her rank as a wool center is second only to that of Boston, where she ships one-half of the wool produced in the Northwest. One-fourth goes to Portland mills for manufacture. The city also is a prominent regional livestock market, and it has long been known as a lumber center, and at present ten lumber mills are in operation [4] Other industrial activities include furniture manufacture, woolen goods and clothing, fruit canning, and meat packing. The manufactured items, such as clothing, knit goods, bathing suits, and the like, are of especially high quality.

Portland's commercial supremacy in the lower Columbia valley was won in competition with several other communities. Astoria, Oregon City, and Vancouver (Washington) offered their several advantages of location and site, but in each instance superiority was undeniably in Portland's favor. Her position near the head of navigation, accessibility to the products of the Willamette and Tualatin valleys, and command of the Columbia gorge were important factors in her growth

At the present time nearly 80 per cent of Portland's residents live east of the Willamette River The extensive river terraces offered good building sites, and land routes from the east, north, and south converge upon East Portland. The core of the commercial district, however, occupies the western side of the river, where early contacts with farmers

[4] Their total annual cut, however, is exceeded by that of the two large mills at Longview.

in Tualatin Valley established a trading center. The retail area moved away from riveredge Front Street and the older ornate business structures there have deteriorated. Recently the thickly wooded scenic hill-

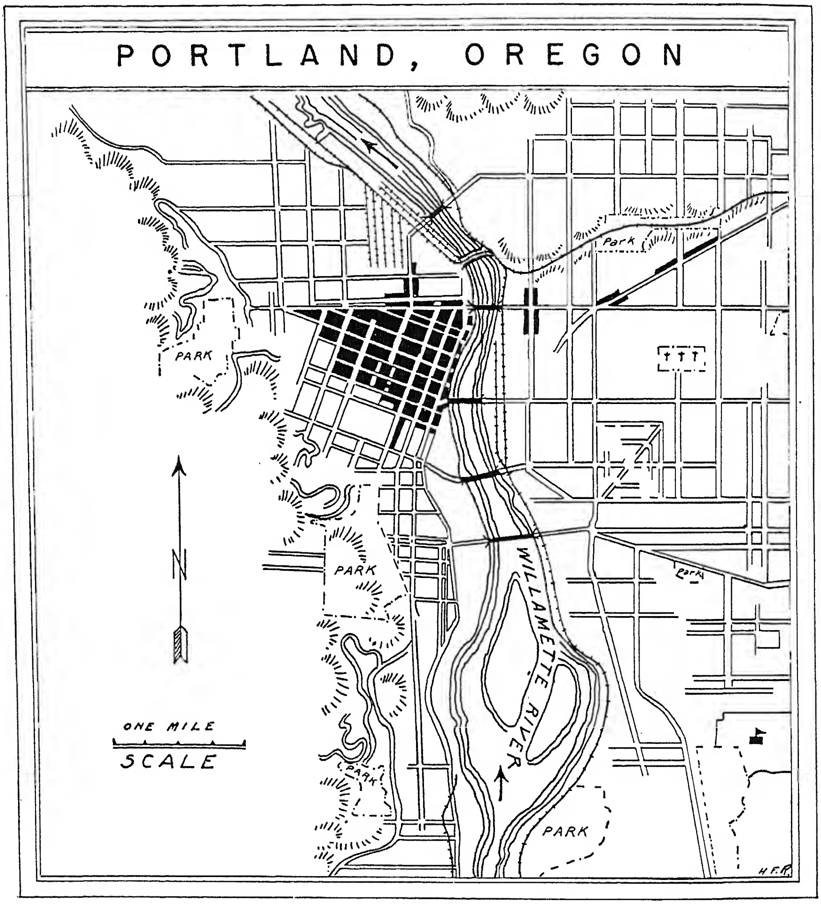

FIG. 139. Plan of Portland.

slopes of the west side have experienced a rapid growth for residential purposes.

In spite of Portland's commercial activity, her residents prefer a leisurely way of life. The community was "in the way to be the New England of the Pacific," according to the Springfield (Mass.) *Republican* in 1871. Quiett, commenting on Portland's attitude toward railroad promotion of 1868, writes, "Staid Portland clasped her mittened hands

and looked on in horrified fascination."[5] Temperamentally, Portland remains a true descendant of the two New Englanders, who, plotting her first streets, tossed a coin to determine which of their home towns should bestow its name upon the settlement—Portland or Boston. Unlike New England cities, however, Portland residents include few of foreign birth, and the percentage of native-born whites in the population is high Until 1910, when Seattle took the lead, Portland was the largest northwestern city; and, although economically the rival on Puget Sound is in the ascendency, in a cultural way the Oregon city still leads

Portland has an interest in books, national problems, art, music, and learning that is more like an old New England town than a community in the pioneer West Its newspapers circulate over a wide territory and are sold extensively in adjoining states Likewise the trade area extends east into Idaho and Washington and south into northern California With railroads and highways running in four directions it is easy to reach Portland and for the city to distribute goods As a result, wholesale and retail trade is important, a fact that is reflected in the character of its business section Because of its central location Portland has become the headquarters for many government agencies and bureaus, is important for branch distributing plants, and is the northwestern headquarters for many eastern corporations

Astoria

Not only is Astoria the oldest white settlement in the Northwest, but it is also a good example of a port whose industries and functions have changed greatly since its foundation. The city began as a fur-trading post in 1811, being located on the southern shore and near the mouth of the Columbia River estuary Later the post was moved to Vancouver and the townsite was nearly abandoned until revived as a sawmill center At the present time Astoria is an important fishing center, canning salmon and tuna, and distributing fresh fish, particularly salmon The city, unfortunately, has a forested and relatively unproductive hinterland to the south, and the estuary can be crossed only by the use of a ferry, so transportation problems have proved insurmountable and Astoria has suffered in consequence Traffic moving along the coast in either direction is forced to visit Astoria because of the need for ferrying, but otherwise the city is removed from main travel routes As early as 1890, it had a population of more than 8,000, and in 1920 it had grown to 14,000, only to decline 26 per cent during the following

[5] *They Built the West.*

decade. Much of the decrease was due to destruction of part of the city by fire in 1922, but location far downstream from the head of Columbia River navigation has limited its growth Though its settlement had priority over competitors, Astoria has not kept pace with other ports better located to serve the Northwest.

MISCELLANEOUS CENTERS

The Recreation Centers. With its great diversity of tourist attractions, many of the permanent residents of the Northwest devote their activities to the accommodation of visitors, and, although this business is a secondary interest in most communities, some towns have been founded primarily for such purposes. These recreation centers cluster around several focal points. the sea coast, the inland lakes, and sunny scenic mountain valleys. Scores of small villages along the Oregon and Washington coasts are permanent centers of population, but with greatly increased numbers of residents during the summer season. Seaside, Oregon, is the largest of these resorts. This town has a good beach and is easily reached by rail and highway, but the accommodations provided and the reputation which has been gained are as important as the natural features in attracting visitors. These coastal resorts are generally "stringtowns" in pattern, with a single main street parallel to the shore. They are especially popular with natives of the Northwest who are unable to travel long distances to reach sunnier coasts during summer, and their cool moist air in summer is appreciated by inhabitants of the warmer interior regions

The mountain resorts are usually better known to tourists who come from other parts of the United States Banff, in British Columbia, has been a favorite stopping place for half a century, and the construction of hotels at Banff Hot Springs and Lake Louise near by is responsible for the continued popularity of this scenic region as a center of recreation From it, highways run in all directions, with connections to Jasper Park on the north and Waterton Park on the American boundary. Similar resorts, though with a different character, are Sun Valley, near Ketchum, Idaho, and Paradise Valley on the slopes of Mount Rainier. Both have been popularized for summer and winter sports, the former by the Union Pacific Railroad, whereas the latter is accessible only by automobile

Tourist centers, to be of importance, must have excellent accommodations for visitors and be well advertised, their scenery must be superior or distinctive. If any one of these elements is lacking, the resort may be unimportant; a case in point is Lake Chelan, which has

some of the finest scenery in the Northwest, yet is visited by comparatively few people because its attractions are not widely known, and it is relatively inaccessible There are numerous other resorts, chiefly visited by local residents, such as Soap Lake at the southern end of Grand Coulee, the Mount Hood area, Quinault and Lake Crescent on the Olympic Peninsula, Vashon Island in Puget Sound, and many in the Rocky Mountains.

Military Centers There are few military centers, with the exception of Fort Lewis, near Tacoma. The former fur-trading and military posts have either been abandoned or have completely changed character after their inception. The only important naval center is Bremerton, whose large shipyards and ships require so many laborers that many of them live in Seattle and commute to their work.

Political Centers. Although political activities lend atmosphere to Olympia, Victoria, Salem, Boise, and Helena, they are by no means the solitary functions of those towns, and no northwestern state capital is the largest city in its state except in rural Idaho Capital cities were selected in early days in large part with reference to their accessibility to the then centers of population. No one of the state capitals is located near the geographical center of its governed area, this is true also of the capitals of Alaska and British Columbia Olympia, at the southern end of Puget Sound, and Salem, forty miles from Portland, are both in the Puget-Willamette Lowland, at long distances from the intermountain portions of their respective states. Boise was selected as the capital during mining days in Idaho, but, with the advent of irrigated agriculture in the southern part of the state, it is not far from the present population center, though distant from the northern panhandle. Helena was also selected during days when mining was the principal industry of Montana and when the population center lay in the southwestern part of the territory Sitka, a small island city off the coast, was abandoned as the capital of Alaska in favor of Juneau, with its greater mining population Both towns, however, are in the Alaska panhandle, away from the geographical center of the territory, but nevertheless near the bulk of the population.

The administrative capitals employ many office workers, and in addition there is a temporary influx of residents when the legislature is in session. Therefore hotels, apartment houses, and rooming houses are in greater demand than in towns of corresponding size elsewhere. Somewhat the same situation prevails in the county seats.

Education Centers. In all the northwestern states, some towns have advanced in growth because of their selection as sites of educational or

other state institutions. Among the cities where an educational institution supplies the largest payroll for the community are Corvallis and Monmouth, Oregon, Pullman and Cheney, Washington, and Moscow and Albion, Idaho. In Missoula and Dillon, Montana, Seattle, Tacoma, Walla Walla, Bellingham, and Ellensburg, Washington, Lewiston, Idaho, and Eugene, Ashland, La Grande, and Salem, Oregon, are institutions which contribute materially to the size of the cities and towns, yet do not dominate the community as in other smaller places

The small city or town dominated by an institution of higher learning usually has two centers of interest—the college itself and a business district in the vicinity of the railroad station. Near the campus and the college buildings are many rooming and boarding houses, fraternity houses, and faculty homes, these may attract certain stores which depend on student trade Often there is a marked separation of the social life, and college and business communities in such towns The physical appearance of these centers is usually superior to that of ordinary trade centers of equal population.

Reservation Centers. The Northwest has one distinctive settlement type, small in size, which is not well known to natives or visitors. It is little more than a village, either on or adjacent to an Indian reservation. A single store, combining several functions, including the postoffice, comprises the business district. The surrounding settlement is distinctive only in its inhabitants, almost all of whom are government wards, having a relatively small annual income They occupy shabby wooden houses, and a general air of decay and listlessness is usually apparent around the settlement. There is no picturesque architecture, few colorful handcrafts except basketry, and no entertaining ceremonials to attract tourists, as is the case in the Southwest Washington communities of this type include the Indian towns of Taholah, Queets, Lapush, and Jamestown

Institution Centers. State hospitals may have more inmates than an educational institution, but the satellite town is usually of small importance, since supplies are secured by contract and not by purchase from local stores Steilacoom and Medical Lake in Washington and Warm Springs, Montana, are examples of such development When institutions are located in larger centers like Walla Walla, Monroe, and Salem they exert only a small effect on the community

Construction Towns. Some few settlements are impermanent Recent reclamation projects such as those at Bonneville Dam and Coulee Dam require many employees who must be housed Boom towns develop during the height of construction activities, then often disappear

as abruptly as they were established, but, unless the town is completely razed, there are some residents who may refuse to leave. At Grand Coulee, the contractors' town, Mason City, and the engineers' town, Coulee Dam, and several other authorized and unauthorized mushroom settlements sprang up. Together, they have accommodated nearly fifteen thousand persons, but, upon completion of the project, Mason City will be razed, and unless new industries develop the population will greatly decline.

A noticeable exodus from these settlements began in 1940. At Bonneville, towns on both sides of the Columbia were smaller than those at Grand Coulee, but like Grand Coulee permanent communities of small size will remain to operate the power plants and serve tourists.

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CHAPTER 27

THE GEOGRAPHIC PATTERN OF POPULATION IN THE PACIFIC NORTHWEST

By Carl H Mapes

The population pattern of the Pacific Northwest presents a number of interesting features which challenge geographical interpretation. It is suggested, therefore, that with the aid of the population map (Fig. 140) the reader make his own analysis of the general Regional pattern, before reading this chapter. Such a procedure offers an excellent opportunity for a review and synthesis of the human adjustments to natural conditions that have been presented in earlier chapters. The purpose of this chapter is the Regional interpretation of the population map

Like other cultural aspects of human geography in the Region, the distributional pattern of population is closely correlated with the major natural features In human settlement, as in other primary distributions, the Cascade Mountains stand out as a dominant regional boundary zone Almost three-fifths of the people of the Northwest live in the marine section west of the Cascades, which includes less than one-fifth of the total area Here the rural pattern of valley clusters and strings represents an adjustment to surface and soil conditions in the humid lowlands, whereas the larger urban concentrations reflect the commercial importance of interconnections between major land and water transportation routes

In the continental interior, east of the Cascades, the population pattern is one of dispersion rather than concentration. Here a little more than two-fifths of the Region's population are widely scattered over four-fifths of the total area. Three distinct rural patterns may be recognized (1) the separated clusters in the valleys tributary to the Columbia and Snake rivers, where a combination of water supply, sloping topography, and pedocal soils makes irrigated farming possible, (2) the even distribution throughout the plateau areas, where density varies with sufficiency of rainfall for dry farming or ranching; and (3) the strings of settlement in the mountain valleys, which offer access to otherwise isolated soil, forest, and mineral resources. With

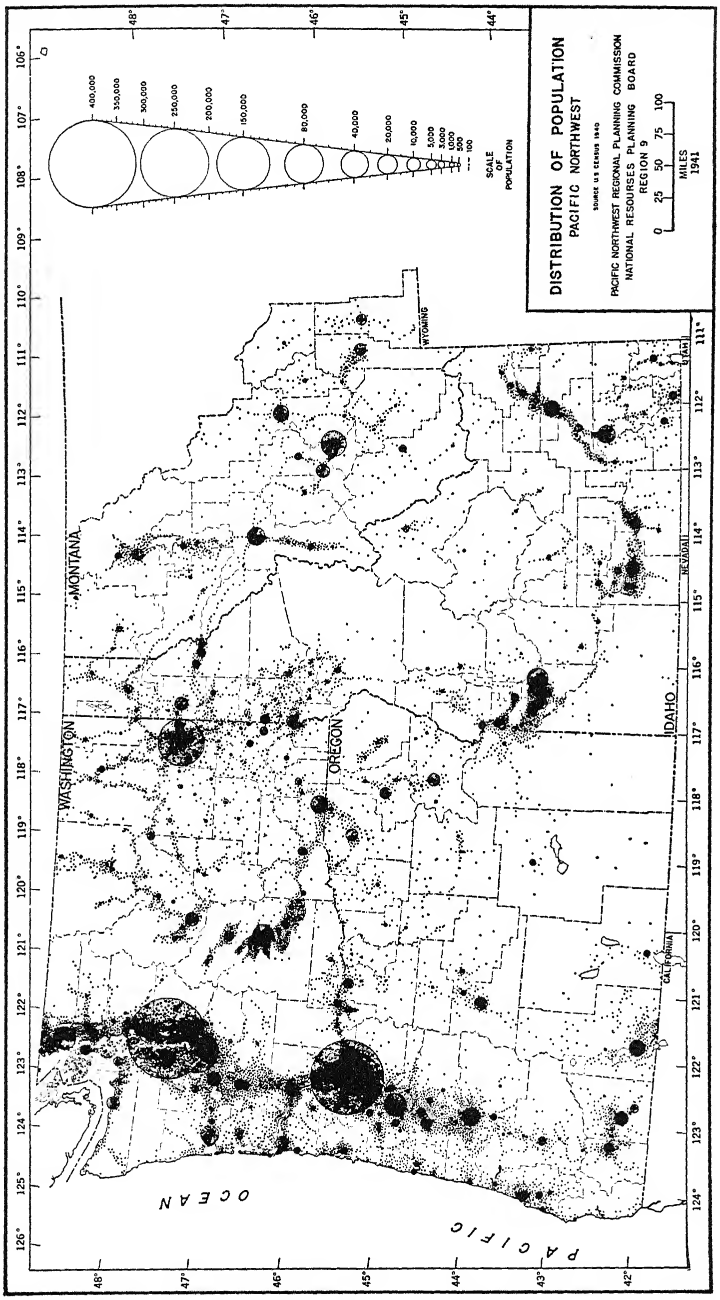

Fig. 140. Distribution of population. (Census of 1940.)

the exception of the two largest cities, the urban pattern portrays the normal association of trading centers with rural areas Spokane, however, serves as the common assembly and distributing center for both the plateau and northern valley populations of the northern intermountain area called the "Inland Empire," and Butte is highly specialized, being known as one of the largest mining camps in the world

The empty areas on the map are fully as expressive of the influence of natural conditions upon population as are the dots and circles which show human settlement. In the West, these vacant spaces represent areas where rugged relief and excessive rainfall effectively limit economic activities. The Olympic Mountains, Coast Ranges, Klamath Mountains, and Cascades all stand out as having extremely sparse population. East of the Cascades, however, aridity as well as mountain conditions helps to account for thinness of settlement. Thus, lack of rainfall is responsible for the scanty population in southeastern Oregon and neighboring Idaho, and in the Columbia Basin of Washington, whereas relief is the controlling factor in the northern and eastern mountainous parts of the Inland Empire

Subregional Patterns of Population

Further analysis of the population map reveals some eight distinct patterns of human occupancy, each with its dominant complex of natural conditions affecting the possibilities of human settlement. These subregions, together with their 1940 populations and percentages of the Regional total, are listed in Table 36 Reliance upon census divisions made it necessary to follow county lines in determining most of the subregional boundaries. The fact that groups of counties can be used for such divisions of population patterns is in itself striking evidence of the close relationhip between cultural and natural features in the Pacific Northwest

TABLE 36

Population Regions	Approximate Population	Per Cent of Total Population (1940)	Per Cent Total Area
1. Coastal Zone	160,000	4 5	4 0
2. Puget-Willamette Lowlands	1,868,000	53 0	13 0
3. Irrigated Cascade Valleys	339,000	9 5	13 0
4. Irrigated Snake River Plain	380,000	10 5	13 0
5 Columbia Basin and Plateaus	394,000	11 0	10 0
6 Arid Basins and Ranges	17,000	5	11 5
7 Northern Rocky Mountain Valleys	153,000	4 0	11 5
8. Central Mountain Belt	253,000	7 0	24 0
Regional total	3,564,000	100 0	100 0

A brief appraisal of the above table brings out some suggestive facts about the geographic foundations of population in the Northwest. As already noted, almost 60 per cent of the total population is found in the two regions west of the Cascades where marine influences dominate. Some 20 per cent is supported by irrigation in the valleys tributary to the Columbia and Snake rivers. About 11 per cent is distributed rather sparsely over the arid and semiarid plateaus and plains lying

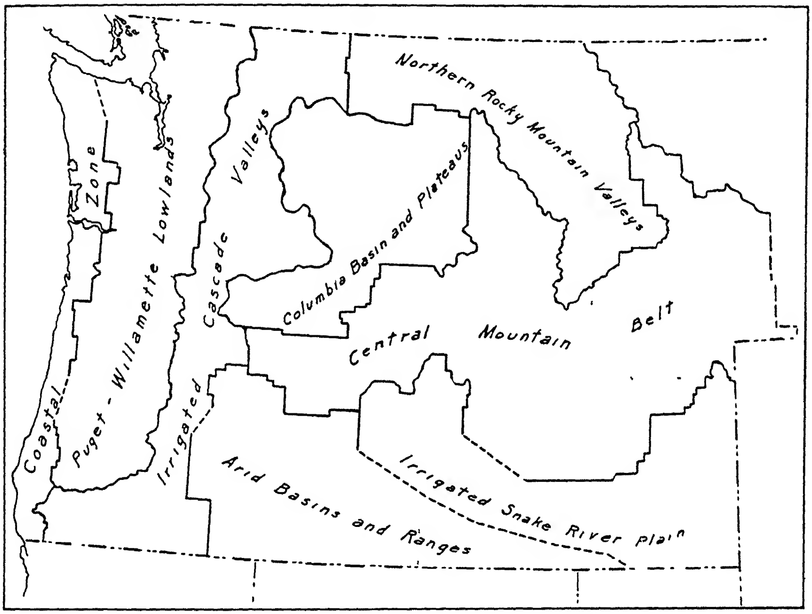

FIG. 141. Population regions of Pacific Northwest

between the Cascades and the Rockies. And another 11 per cent is scattered widely throughout the narrow valleys and trenches of the Rocky Mountains. Thus it is possible to reduce our eight subregions to four main types, one west and three east of the Cascades (Fig. 141): (1) marine lowlands, (2) irrigated valleys, (3) plateau and basin areas, and (4) interior mountain valleys. With these divisions, a tabulation has been made of comparative population growth during the last fifty years. Results are shown by the bar graph (Fig. 142). As can be seen, the proportions between western and eastern populations have remained fairly constant throughout the entire period, but within the eastern division there has been a relative increase in the irrigated valleys and a corresponding decline in the plateau and mountain

areas. The fact that these last two sections of the Northwest have had only a slight actual increase in population during the last thirty years may indicate that they have reached the point of saturation under existing economic conditions The adjustment of population to resources appears to have reached the stage of maturity.

The Coastal Zone

When one considers the nature of the physical environment in the narrow strip of territory that lies between the Coast Ranges and the Pacific Ocean, it is not difficult to understand why this region is low in population. Exposed to the saturated westerlies and backed by hill and mountain barriers, it is a zone of excessive rainfall, with poor podzolic soils and limited areas of level land. Although there is a relatively long frost-free season, temperatures are low even in summer. Consequently, there is limited agricultural foundation for a rural population. The long, cool, rainy growing season is, however, extremely favorable to forest growth, and the various species of northern coniferous trees reach their maximum in size and timber yield

The dominant geographic control of population in the Coastal Zone is therefore climate, as it finds expression in low growing temperatures, leached soils, and dense forest growth, with rugged hill and mountain topography also of major significance. Within the region, population is largely concentrated in small seaport centers where harbor facilities make it possible to utilize cheap ocean transportation in the marketing of forest products. Because of ocean gateways to the inner lowlands by way of the Strait of Juan de Fuca and the Columbia River, however, the coastal harbors serve only as local export centers for their immediate timber hinterlands

Population based upon forest exploitation is only semipermanent and tends to decline with the depletion of its original resource base, unless the land can be used for agriculture The fifty-year population curve for Grays Harbor County in Washington shows that the declining stage has already begun in the coastal section of the Northwest. Between 1930 and 1940, this typical lumbering county experienced the greatest absolute decrease in population of any county in the Pacific Northwest, with a loss of about 8,000 inhabitants or 13.5 per cent of its 1930 total of about 60,000 Since forest depletion has progressed farther in this area than in any other along the coast, the decline here may be regarded as a portent of what will follow in other sections as the original stand of timber is removed, unless new industries start and succeed.

The Puget-Willamette Lowlands

It is the concentration of population in the 400-mile lowland lying between the Coast and Cascade ranges that is the most striking demographic feature of the Pacific Northwest. The main geographic reasons for this have already been established in the many special studies which have been presented, but it may be well to summarize them briefly. In the first place, only in the Willamette Valley did the land-seeking pioneer farmer find a combination of rainfall, temperature, soil, and surface conditions favorable to subsistence agriculture In the Puget Sound area, and to less degree in Oregon because its forests were relatively inaccessible, the almost solid mantle of commercial timber which originally covered and surrounded the region provided a rich and easily exploited source of natural wealth which attracted and gave support to a large number of semiskilled workers in mill town and logging camp. Moreover, the fact that Puget Sound and the Columbia River extended an ocean highway into the very heart of the interior lowland led to the establishment and growth of seaport cities to serve as both regional and national shipping centers. And, finally, the development of great hydroelectric power resources is bringing an increasing number of new manufacturing industries to tidewater locations.

Although essentially alike in their major natural advantages as centers of population, the northern and southern basins of this great trough differ in certain important respects, and these differences are clearly reflected in their respective population patterns The southward extension of Puget Sound brings the advantages of ocean transportation to a considerable inland area In actual practice Puget Sound is one huge port, with its import trade handled largely by the shipping facilities of Seattle, but with its export business divided among the various ports along its shores Most of the large sawmills have their own docks where lumber can be loaded directly from mill yard to ship with a minimum of handling expense. Many of the vessels entering Puget Sound will call at several of the smaller sawmill ports in order to obtain a full cargo This service favored the growth of a number of medium-sized cities along the shores of this inland sea that serve as export centers for their timbered hinterlands while some also develop into trading centers for small agricultural areas In the Willamette Valley, on the other hand, both the import and the export trade are concentrated at Portland. A number of subsidiary export centers are found along the north-south stretch of the Columbia, between Vancouver and Longview Salem and the smaller cities of the northern Willamette Valley are primarily local trading centers dependent upon

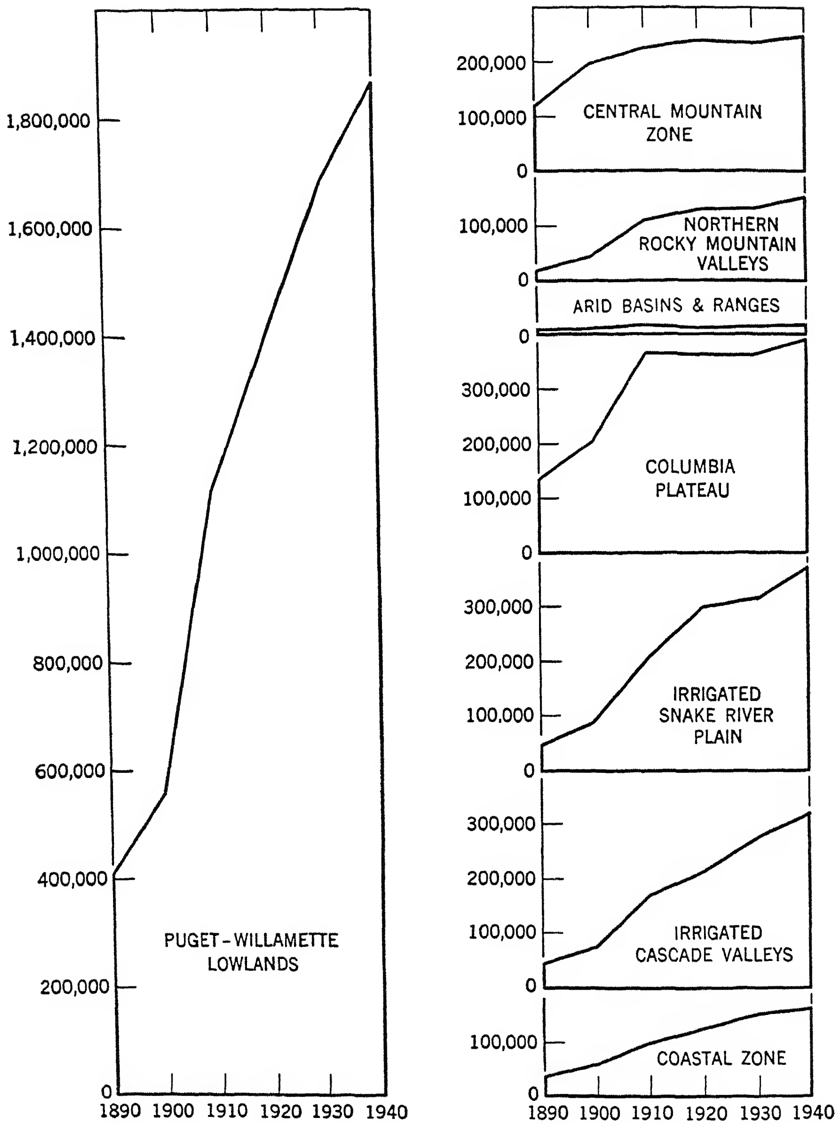

FIG 142 Population growth by selected regions.

surrounding agricultural areas and upon small-scale lumber operations. Eugene, near the south border of the Valley, was long an important trading center before large sawmills and veneer plants began operations that have caused the population to increase in recent years

Comparatively small areas of land in the Puget Basin are favorable for agriculture as compared with the Willamette Valley, the reasons for which are made clear by referring to the chapters on physical features and soils. The cultivated land consists of shoestring valleys, deltas, and flood plains of the larger rivers and drained sites of glacial lakes. The interstream upland soil of glacial origin is excessively permeable and has been so thoroughly leached that it does not make good farmland In consequence, these well-drained uplands, with an elevation of 200 to 500 feet above sea level, form an irregular pattern of sparsely populated areas, partially or entirely surrounded by delta clusters and valley string in the alluvial bottom lands. Only where they border upon the harbors of Puget Sound, and can be utilized as city sites or suburban centers, are the uplands densely settled.

Population in the Puget Sound area is almost entirely confined to the lands below an elevation of 500 feet Above this height the glacial uplands merge rapidly into the mountain slopes. The heavy rainfall and thin rocky soils of the mountains and foothills give them value chiefly as forest-growing lands. A sustained yield program must be immediately established if the mills that support a considerable part of the population are to receive a perpetual supply of timber and pulp wood.

The rural pattern of the Willamette Valley reflects more favorable topographic and soil conditions for agriculture than are found in the Puget Sound area. Population is more evenly distributed throughout the lowland section and the lateral valley strings are much less prominent. Including Clark County, Washington, which is structurally and economically a part of the Willamette Valley, the twelve southern counties of the Puget-Willamette Lowland average close to 40 per cent of their area in farms whereas the fifteen northern counties average slightly less than 16 per cent More uniform valley topography and agricultural soils are chiefly responsible.

Irrigated Cascade Valleys

The arid eastern valleys of the Cascade Mountains present an altogether different natural setting for human activities from that of the western lowlands. Population is clustered in scattered localities where water supply, valley slopes and soils, and length of growing season are

combined in proportions which permit the development of various types of irrigation agriculture. Towns and cities are roughly proportional in size to the rural areas that they serve, except where lumbering operations that utilize the near-by pine forests add to the population base.

Favorable natural conditions and diversification of its irrigated crops are largely responsible for the major concentration of population in the Yakima Valley, whose 100,000 people constitute about 30 per cent of the entire population of the irrigated Cascade Valleys. The next largest cluster is that of the well-developed Rogue River in southwestern Oregon, which, although west of the main Cascade range, belongs among the irrigated valleys owing to its location in the lee of the Klamath Mountains.

The Kittitas Valley in Washington and the upper Deschutes and Klamath valleys of Oregon are so high that farmers must depend upon root and forage crops, with the result that the population density is less than in fruit-raising sections In Oregon, however, both Bend and Klamath Falls are important inland sawmill centers, and their size is only partly related to the surrounding farms.

The Irrigated Snake River Plain

With natural conditions in general about like those of the eastern Cascade valleys, the Snake River Plain of southern Idaho has also developed a clustered pattern of population dependent upon irrigation adjustments. Three distinct centers stand out on the map: the upper valley above American Falls Reservoir, the central area around Twin Falls and Burley; and the lower tributary valleys of the Boise, Payette, Owyhee, and Malheur rivers. Water supply has been the limiting physical factor in the development of these areas and costly storage projects have been necessary to provide sufficient water for summer needs. Since a considerable area suitable for irrigation is still available in the lower plain between Twin Falls and the Boise basin, additions to the population can be expected when the economic demand for new agricultural land will justify the expenditure.

The Columbia Plateau and Arid Basins

Although these two regions combined contain 21 per cent of the land area of the Northwest, they support only about 11 per cent of the population, practically all of which is concentrated in the crescent-shaped wheat belt of northern Oregon and eastern Washington. The rural dry-farming areas have shown a steadily declining population for the

last thirty years, owing in large part to the mechanization and consolidation of farms. Census results for 1910 show a greater population for the plateau area then, than in either 1920 or 1930. And although the census of 1940 shows an increase of about 30,000 over that of 1930, this is accounted for largely by urban growth in the Spokane district and by the temporary increase in the Grand Coulee Dam construction center.

The natural resource base of population in the plateau region is its fertile soils which, where rainfall is sufficient, are favorable for the growing of wheat by dry-farming practices. Much of the area, however, receives only enough precipitation for open-range grazing, and therefore supports a sparse population. The fact that the Columbia and Snake rivers flow through the plateau in canyons several hundred feet below the surface of the land has made it impracticable in the past to use their water supply for irrigation even where surface conditions were favorable. Only the construction of a super power and irrigation project such as Grand Coulee can bring water to any considerable area of the plateau surface. The completion of the irrigation program of this project will, of course, bring marked changes in the population pattern of the Columbia Plateau during the next twenty years. Thus man, with his everchanging culture and technology, will once more demonstrate his ability to alter the cultural landscape of a region through the utilization of new combinations of natural conditions.

The Northern Rocky Mountain Valleys

This subregion of Pacific Northwest population includes practically all of the drainage basin of the Columbia River and its tributaries above the Okanogan. The major valleys are the Colville and Pend Oreille in northeastern Washington, the Pend Oreille Lake and Kootenai valleys of the Idaho panhandle, and the Rocky Mountain Trench of the Bitterroot, Missoula, and Flathead valleys in northwestern Montana. Of the 153,000 people who live in this part of the Northwest, almost two-thirds are found in the Rocky Mountain Trench, where the greatest area of valley agricultural and grazing land is located. The stringlike pattern of population is clearly determined by the trends of the valleys and trenches. Towns and cities are located either at the junction of two or more valleys, such as Missoula and Sandpoint, or near the middle of a valley chain of settlement, such as Colville and Kalispell. The forests of the mountain slopes also provide a major resource base for employment, and most of the cities of the

region are lumber-manufacturing as well as trading centers Mining operations are scattered throughout the area, and many communities have increased importance because of this. The maintenance and operation of railroads provide considerable employment, as three transcontinental lines make use of these northern valleys to cross the Rocky Mountains Improvements of the highways and the expansion of tourism and recreation help greatly to support settlements along the main routes.

Central Mountain Belt

A comparison of the population with the physiographic map of the Pacific Northwest will show that this subregion includes almost all the high mountain masses and narrow upper valleys of the Rocky Mountain Ranges in the east-central section of the Region Although the largest of the population regions into which we have divided the Northwest, with 24 per cent of the total area, it supports only 7 per cent of the population and has the unusually low average density of less than four persons to the square mile Here, as in other parts of the Northwest, however, density figures have little significance owing to the clustered character of population distribution. More than half the people of this wide mountain belt are concentrated in the eight counties of southwestern Montana, where mineral deposits form the basis of the major resource industries The Butte district shows a notable number of inhabitants for a high mountain location. Another mining concentration occurs around Wallace and Kellogg in northern Idaho Smaller mining operations are found also in the Salmon River region of Idaho and the Blue Mountains of Oregon.

In addition to mining, the grazing of sheep and cattle on high summer pasture lands and the production of forage crops in the narrow valleys are the chief means of support. Forests along the more accessible borders of the region yield considerable timber, but most of it is transported to outside cities in the plateau and lower valley regions for conversion into lumber Baker and La Grande in valleys east of the Blue Mountains are local sawmill and supply centers.

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